

Marine Fish and Invertebrate Atlas: Summarizing Geographic Distribution and Population Indices in the Scotian Shelf and Bay of Fundy (1970-2020)

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6 MARINE FISH AND INVERTEBRATE ATLAS: SUMMARIZING GEOGRAPHIC DISTRIBUTION,
7 POPULATION INDICES AND ENVIRONMENTAL PREFERENCES IN THE SCOTIAN SHELF
8 AND BAY OF FUNDY (1970-2020)

by

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ABSTRACT

166 Ricard, D., Emberley, J., Gomez, C. and Regnier-McKellar, C. 2021. Marine Fish and Invertebrate
167 Atlas: Summarizing Geographic Distribution, Population Indices and Environmental
168 Preferences in the Scotian Shelf and Bay of Fundy (1970-2020). Can. Tech. Rep. Fish. Aquat.
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170 The summer groundfish research vessel survey on the Scotian Shelf and in the Bay of
171 Fundy started in 1970 and was designed to measure the distribution and abundance of
172 major commercial fish species. Over time, additional information on non-commercial species
173 was collected, and allowed considerable insight into ecosystem function and structure, as
174 documented in many primary publications whose analyses used the survey data. The same
175 groundfish survey database has also been used to produce species status reports, atlases of
176 species distribution and remains an essential source of information for stock assessments in the
177 Maritimes Region of Fisheries and Oceans Canada. This report builds on previous work and
178 former atlases by updating a comprehensive suite of indices to assess population status and
179 environmental preferences of 104 species. For each species, trends in geographic distribution
180 and biomass or abundance were plotted. The spatial extent of distribution was plotted over
181 time to gauge how the area occupied has changed. The relationship between abundance or
182 biomass and spatial extent reflected whether the species distribution expands when abundance
183 or biomass increases. Length frequencies over time depicted any changes in mean size. The
184 plots of condition over time revealed whether individual fish are fatter or thinner than their long
185 term mean. Depth, temperature and salinity preferences were estimated to gauge the range
186 of suitable environmental parameters for each species. Finally, for each stratum, the slope
187 describing how local density varies with regional abundance was estimated.

RÉSUMÉ

189 Ricard, D., Emberley, J., Gomez, C. and Regnier-McKellar, C. 2021. Marine Fish and Invertebrate
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191 Preferences in the Scotian Shelf and Bay of Fundy (1970-2020). Can. Tech. Rep. Fish. Aquat.
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193 Le relevé estival par navires de recherche sur le poisson de fond sur le plateau néo-écossais
194 et dans la baie de Fundy a débuté en 1970 et visait à mesurer la répartition et l'abondance
195 des principales espèces de poissons commerciales. Au fil du temps, des informations
196 supplémentaires sur les espèces non commerciales ont été recueillies et ont permis de mieux
197 comprendre la fonction et la structure de l'écosystème, comme le montrent de nombreuses
198 publications primaires dont les analyses ont utilisé les données des relevés. La même base
199 de données sur les relevés du poisson de fond a également été utilisée pour produire des
200 rapports sur la situation des espèces, des atlas de la répartition des espèces et demeure une
201 source essentielle d'information pour les évaluations des stocks dans la région des Maritimes
202 de Pêches et Océans Canada. Ce rapport s'appuie sur des travaux antérieurs et d'anciens
203 atlas en mettant à jour une série complète d'indices pour évaluer l'état de la population et les
204 préférences environnementales de 104 espèces. Pour chaque espèce, les tendances de la
205 répartition géographique et de la biomasse ou de l'abondance ont été tracées. L'étendue spatiale
206 de la distribution a été tracée au fil du temps pour évaluer comment la zone occupée a changé.
207 La relation entre l'abondance ou la biomasse et l'étendue spatiale indique si la répartition des
208 espèces augmente lorsque l'abondance ou la biomasse augmente. Les fréquences de longueur
209 au fil du temps représentaient tout changement dans la taille moyenne. Les graphiques de l'état
210 au fil du temps ont révélé si les poissons individuels sont plus gros ou plus minces que leur
211 moyenne à long terme. Les préférences en matière de profondeur, de température et de salinité
212 ont été estimées pour évaluer la gamme de paramètres environnementaux appropriés pour
213 chaque espèce. Enfin, pour chaque strate, la pente décrivant comment la densité locale varie
214 avec l'abondance régionale a été estimée.

1 Introduction

216 The summer (July-August) groundfish research vessel survey on the Scotian Shelf and in the
217 Bay of Fundy was started in 1970 by Fisheries and Oceans Canada Maritimes Region. The
218 survey was originally designed to measure the distribution and abundance of major commercial
219 fish species. Over time, information on non-commercial species was also collected. The
220 groundfish survey database storing the information collected during the annual survey provides
221 the main source of fisheries-independent information for marine species in the region. This
222 information is routinely used to support stock assessments, to produce species status reports
223 and has been previously used to publish atlases of species distribution.

224 The current document is an update of an earlier report (Ricard and Shackell 2013) that built on
225 former atlases by updating a comprehensive suite of derived indices for 104 species to assess
226 population status and environmental preferences. The information collected during the survey is
227 stored in a relational database management system archived at Fisheries and Oceans Canada
228 Maritimes Region which contains detailed information about the sampling locations and the
229 associated catch. Tow-level survey data is also publicly available from the Ocean Biogeographic
230 Information System (DFO 2016) and (DFO 2021). The present atlas follows on the work done
231 by Fisheries and Oceans colleagues from the northern Gulf of St. Lawrence (Bourdages and
232 Ouellet 2012), southern Gulf of St. Lawrence (Benoît et al. 2003) and on earlier work in the
233 Scotian Shelf (Simon and Comeau 1994; Horsman and Shackell 2009).

234 To facilitate updates and foster collaboration on the analyses of the survey data, the computer
235 code necessary to extract the data, to perform the analyses presented herein, and to reproduce
236 and update the current document is made available in a git repository (Ricard and Gomez 2021).

237 The survey area covers three major Northwest Atlantic Fisheries Organization (NAFO) zones
238 that divide the shelf into the colder east 4V and 4W (strata 440-466) and warmer west 4X (strata
239 470-495). Temporal trends are plotted by NAFO regions for several species. For each species,
240 trends in geographic distribution and biomass or abundance are plotted. Some caution is
241 required in interpreting the results obtained for several taxa due to low sample size as explained
242 later in the text. The spatial extent of distribution is plotted over time to gauge how the area
243 occupied has changed. The relationship between biomass and spatial extent reflects whether the
244 species distribution expands when biomass increases. For each strata, the slope describing how
245 local density varies with regional abundance was estimated (Myers and Stokes 1989). These
246 slopes were then plotted against a habitat suitability index to identify important strata for each
247 species. Then, length frequencies over time depicted any changes in mean size. The plots of
248 condition over time revealed whether individual fish are fatter or thinner than their long term
249 mean. Finally, depth, temperature and salinity preferences were estimated to gauge the range
250 of environmental parameters (Perry and Smith 1994). A full ecological interpretation of trends
251 is beyond the scope of this report. Other documents stemming from peer-reviewed scientific
252 processes under the auspices of the [Canadian Science Advisory Secretariat](#) (CSAS) provide
253 further descriptions of spatio-temporal trends in different indicators and put the information
254 collected during the summer groundfish research vessel survey in a more focused context (see
255 for example Clark and Emberley (2011)).

2 Methods

257 2.1 Survey Description

- 258 The survey is conducted annually in July-August and covers the Scotian Shelf and the Bay of
 259 Fundy (Figure 1). It normally involves two separate two-week trips on board an offshore fisheries
 260 vessel from the Canadian Coast Guard.
- 261 A number of changes in fishing gear type and vessels used occurred since the onset of sampling
 262 activities (Clark and Emberley 2011).

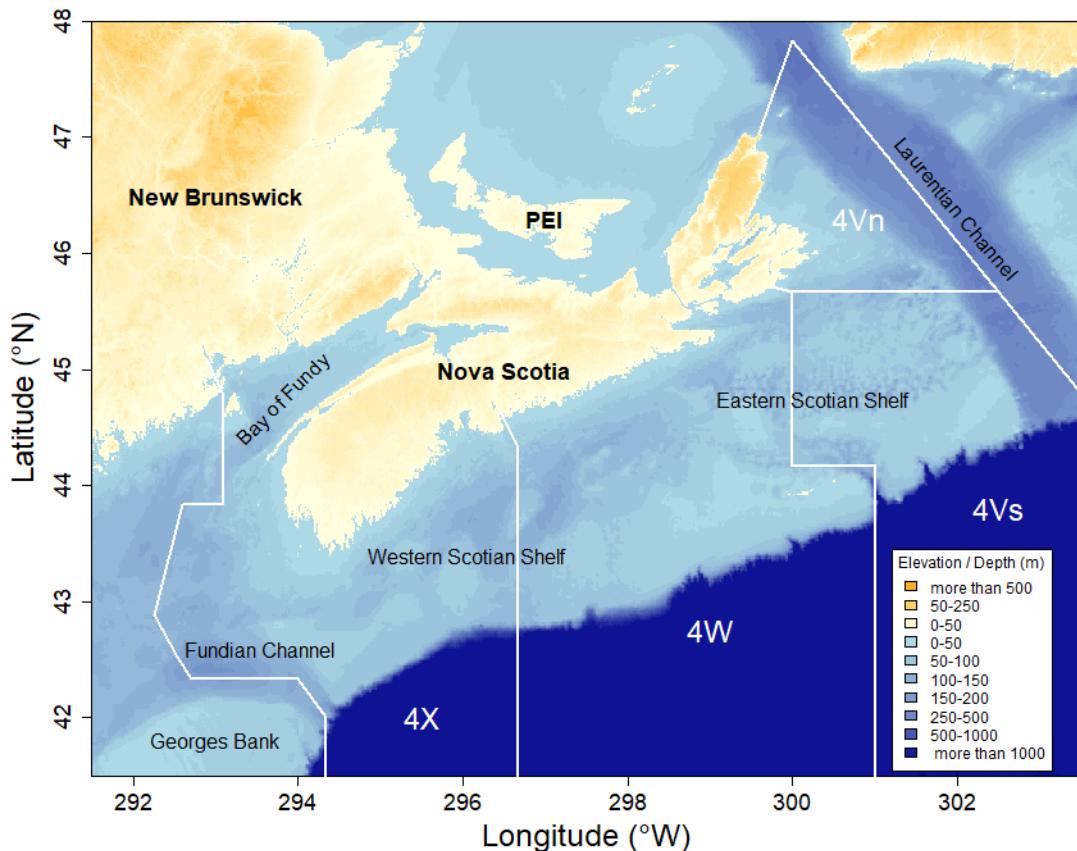


Figure 1. Map of the Scotian Shelf and Bay of Fundy where the DFO Maritimes Summer survey takes place. The bathymetry presented here is the 15 arc-second gridded data set from the General Bathymetric Chart of the Oceans ([GEBCO](#)). Geographical locations of interest and the boundaries of relevant NAFO Divisions are also shown on the map.

263 2.2 Sampling Design

- 264 The summer survey covers divisions 4V, 4W and 4X of the Northwest Atlantic Fisheries
 265 Organization (NAFO) which includes the Scotian Shelf and the Bay of Fundy. The eastern limit of
 266 the survey is the Laurentian Channel and the western limit is the Fundian Channel (Figure 1).

267 The survey follows a stratified random design (Doubleday and Rivard 1981; Lohr 1999)
268 (Figure 2). The number of tows conducted in each stratum is approximately proportional to
269 its surface area. The area covered during the survey has remained constant since its onset,
270 with the exception of additional deeper strata that were only sampled a few times since 2000.
271 Because the sampling of the deeper strata is not conducted every year, the analyses presented
272 herein only include strata 440 to 495 which cover NAFO Divisions 4V, 4W and 4X (Figure 2 and
273 Table 1).

274 The basic sampling unit of the survey is a 30-minute fishing tow conducted at a speed of 3.5
275 knots. This yields a distance towed of 1.75 nautical miles.

Table 1. Summer survey strata details. The strata used in the analyses are presented separately for NAFO Divisions 4Vn, 4VsW and 4X. For each stratum, the depth range in fathoms and the surface area in square kilometers are reported.

Stratum	Depth range (fathom)	Area (km ²)
4Vn		
440	101-200	924
441	51-100	1000
442	0-49	1437
4VsW		
443	0-49	1318
444	51-100	3925
445	101-200	1023
446	101-200	491
447	0-49	1616
448	0-49	1449
449	51-100	144
450	51-100	383
451	101-200	147
452	101-200	345
453	101-200	259
454	51-100	499
455	0-49	2122
456	0-49	955
457	51-100	811
458	0-49	658
459	0-200	3148
460	51-100	1344

NAFO Div.	Stratum	Depth range (fathom)	Area (km ²)
	461	101-200	1154
	462	51-100	2116
	463	0-49	302
	464	0-50	1297
	465	51-100	2383
	466	101-200	226
4X			
	470	51-100	920
	471	101-200	1004
	472	51-100	1249
	473	0-49	265
	474	0-49	161
	475	0-49	156
	476	51-100	1478
	477	51-100	1232
	478	101-200	233
	480	0-49	655
	481	51-100	1875
	482	101-200	1042
	483	101-200	532
	484	101-200	2264
	485	51-100	1582
	490	0-49	601
	491	51-100	687
	492	51-100	1086
	493	0-49	533
	494	0-49	417
	495	0-49	584

²⁷⁶ After each tow the catch is sorted by species and weighed. Each fish caught is then measured,
²⁷⁷ and further sampling of individual fish weight, maturity status and age are performed for different
²⁷⁸ length classes. When catches exceed 300 individuals, a random sub-sample is used to obtain

279 the length and weight measurements.

280 The location of representative tows appears in Figure 3.

281 **2.3 Taxonomic Levels**

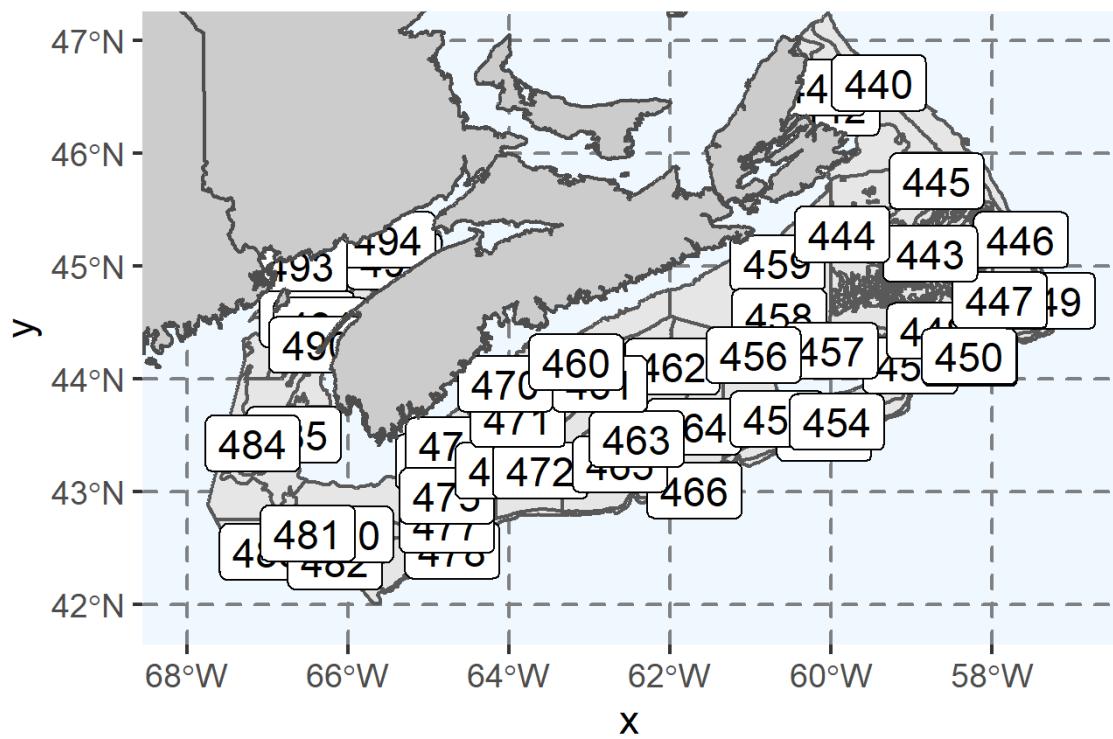
282 Fish species caught during the surveys are identified by trained scientific personnel and their
283 scientific name is determined. An internal species code used in the relational database is
284 reported for each species (Losier and Waite 1989).

285 By its nature as a bottom trawl, the fishing gear used in the survey catches certain species
286 better than others. To ensure that meaningful ecological information can be extracted from
287 catch samples, we report the catch records for the subset of species that are caught reliably
288 by the gear. To appear in this atlas, a species must have had a minimum of 10 observations over
289 the duration of the survey activities. While both catch abundance and weight are recorded, the
290 weight of species that appear at low abundances is often recorded as zero in the earlier parts of
291 the survey when scales of appropriate precision were not available.

292 We divided the species caught into five categories based on 1) their taxonomic classification,
293 2) the number of recorded observations, and 3) their period of valid identification (Table 2).
294 Category "LF", for "long frequent", was assigned to species that have more than 1000 records
295 since 1970 and have been consistently identified since the onset of the survey. Category
296 "LI", for "long intermediate", was assigned to species that had between 1000 and 200 catch
297 records. Rare and elusive species (those with less than 200 catch records over the duration
298 of the survey) are also reported but to a lower level of analytical details (Category "LR", for
299 "long rare"). Category "SF", for "short frequent", was assigned to invertebrate species that were
300 consistently sampled only since 1999 (Tremblay M. J. 2007). And category "SR", for "short rare"
301 for invertebrate species consistently sampled only since 1999 and with less than 200 catch
302 records. The list of taxa covered in this document is presented in phylogenetic order (Nelson J.
303 S. et al. 2004) in Table 3. To ensure concordance with authoritative taxonomic information, the
304 AphiaID from the World Register of Marine Species is also provided in Table 3 (Appeltans et al.
305 2012).

Table 2. Taxonomic levels used to determine the analytical treatment for each species.

Category	Name	Description
L	long - consistently identified since the onset of the survey in 1970	
LF	long frequent	species that have more than 1000 catch records
LI	long intermediate	species that had between 1000 and 200 catch records
LR	long rare	species with less than 200 catch records
S	short - invertebrate	species that were consistently sampled only since 1999
SF	short frequent	species with more than 200 catch records
SR	short rare	species with less than 200 catch records



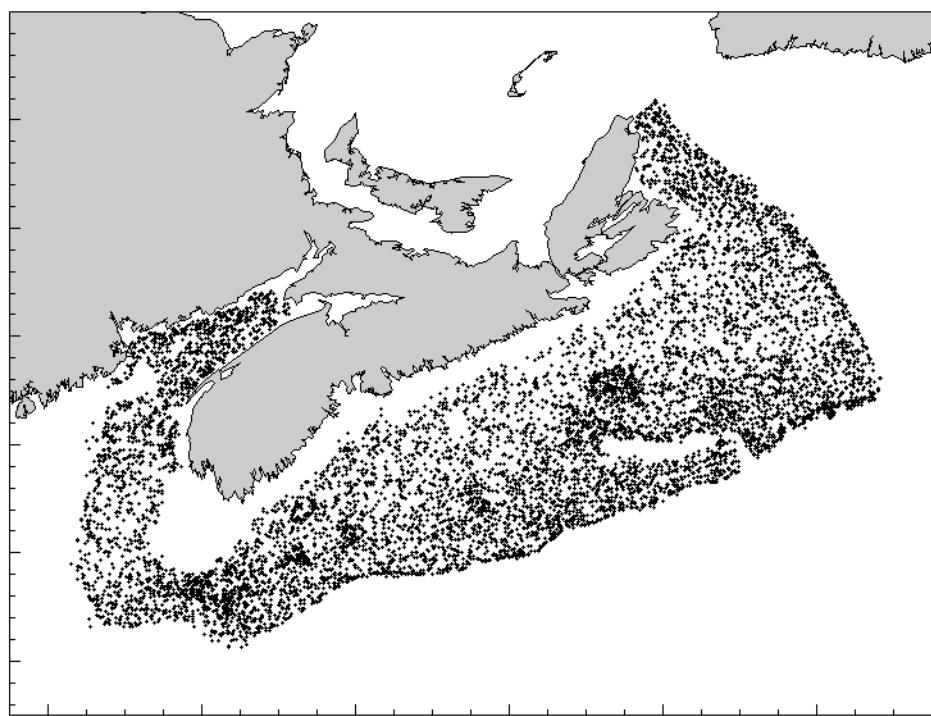


Figure 3. Map of the Summer survey tows.

Table 3. List of species included in the Atlas. The species reported here are listed in phylogenetic order as per Page L. M. et al. (2013). For each taxonomic order and class, each species is listed in the table, its taxonomic family and scientific name is provided, along with its French and English common names, the species code used in the survey database, its AphiaID and a link to the World Registry of Marine Species, its number of catch records in the survey database and its classification category as defined in section 2.3.

	Family	Scientific name	English name	French name	Species code	AphiaID	Num. records	Category
Myxini								
<i>Myxiniformes</i>								
	Myxinidae	<i>Myxine glutinosa</i>	Atlantic hagfish	Myxine du nord	241	101170	804	LI
Petromyzonti								
<i>Petromyzontiformes</i>								
	Petromyzontidae	<i>Petromyzon marinus</i>	Sea lamprey	Lamproie marine	240	101174	16	LR
Actinopterygii								
<i>Gadiformes</i>								
	Gadidae	<i>Gadus morhua</i>	Atlantic cod	Morue franche	10	126436	5451	LF
		<i>Melanogrammus aeglefinus</i>	Haddock	Aiglefin	11	126437	5827	LF
	Phycidae	<i>Urophycis tenuis</i>	White hake	Merluche blanche	12	126504	3524	LF
		<i>Urophycis chuss</i>	Red hake	Merluche écureuil	13	126503	2195	LF
	Merlucciidae	<i>Merluccius bilinearis</i>	Silver hake	Merlu argenté	14	158962	4936	LF
	Lotidae	<i>Brosme brosme</i>	Cusk	Brosme	15	126447	688	LI
	Gadidae	<i>Pollachius virens</i>	Pollock	Goberge	16	126441	2787	LF
		<i>Microgadus tomcod</i>	Atlantic tomcod	Poulamon atlantique	17	158928	44	LR
	Merlucciidae	<i>Merluccius albibus</i>	Offshore silver hake	Merlu argenté du large	19	158748	161	LR
<i>Scorpaeniformes</i>								
	Sebastidae	<i>Sebastes</i>	Atlantic redfishes	Sébastes de l'Atlantique	23	126175	4152	LF
<i>Pleuronectiformes</i>								
	Pleuronectidae	<i>Hippoglossus hippoglossus</i>	Atlantic halibut	Flétan de l'Atlantique	30	127138	1634	LF

Class	Order	Family	Scientific name	English name	French name	Species code	AphiaID	Num. records	Category
Perciformes	Gadiformes	Pleuronectidae	<i>Reinhardtius hippoglossoides</i>	Greenland halibut	Flétan noir	31	127144	736	LI
			<i>Hippoglossoides platessoides</i>	American plaice	Plie canadienne	40	127137	6023	LF
			<i>Glyptocephalus cynoglossus</i>	Witch flounder	Plie grise	41	127136	4301	LF
			<i>Limanda ferruginea</i>	Yellowtail flounder	Limande à queue jaune	42	158879	3233	LF
			<i>Pseudopleuronectes americanus</i>	Winter flounder	Limande-plie rouge	43	158885	1632	LF
	Paralichthyidae	<i>Citharichthys arctifrons</i>	Gulf Stream flounder	Plie du Gulf Stream	44	158791	382	LI	
Clupeiformes	Anarhichadidae	<i>Anarhichas</i>	<i>Anarhichas lupus</i>	Atlantic wolffish	Loup atlantique	50	126758	1572	LF
			<i>Anarhichas minor</i>	Spotted wolffish	Loup tacheté	51	126759	20	LR
			<i>Anarhichas denticulatus</i>	Northern wolffish	Loup à tête large	52	126757	17	LR
Osmeriformes	Clupeidae	<i>Clupea</i>	<i>Clupea harengus</i>	Atlantic herring	Hareng de l'Atlantique	60	126417	3487	LF
			<i>Alosa sapidissima</i>	American shad	Alose savoureuse	61	158670	468	LI
			<i>Alosa pseudoharengus</i>	Alewife	Gaspareau	62	158669	977	LI
		<i>Osmerus</i>	<i>Osmerus mordax</i>	Rainbow smelt	Éperlan arc-en-ciel	63	126737	59	LR
Perciformes	Scombridae	<i>Scomber</i>	<i>Mallotus villosus</i>	Capelin	Capelan	64	126735	540	LI
			<i>scombrus</i>	Atlantic mackerel	Maquereau commun	70	127023	696	LI
Gadiformes									

Class	Order	Family	Scientific name	English name	French name	Species code	AphiaID	Num. records	Category
<i>Perciformes</i>	Phycidae	<i>Phycis chesteri</i>	Longfin hake	Merluche à longues nageoires	112	158988	784	LI	
<i>Scorpaeniformes</i>	Lotidae	<i>Enchelyopus cimbrius</i>	Fourbeard rockling	Motelle à quatre barbillons	114	126450	693	LI	
<i>Pleuronectiformes</i>	Labridae	<i>Tautogolabrus adspersus</i>	Cunner	Tanche-tautogue	122	159785	82	LR	
<i>Aulopiformes</i>	Sebastidae	<i>Helicolenus dactylopterus</i>	Blackbelly rosefish	Sébaste chèvre	123	127251	610	LI	
<i>Myctophiformes</i>	Paralichthyidae	<i>Hippoglossina oblonga</i>	Fourspot flounder	Cardeau à quatre ocelles	142	158833	76	LR	
<i>Stomiiformes</i>	Scophthalmidae	<i>Scophthalmus aquosus</i>	Windowpane flounder	Turbot de sable	143	158907	115	LR	
<i>Argentiniiformes</i>	Chlorophthalmidae	<i>Parasudis tricrenata</i>	Longnose greeneye	Oeil-vert à long nez	149	158868	45	LR	
<i>Cottidae</i>	Myctophidae	<i>Myctophidae</i>	Lanternfishes	Poissons-lanternes	150	125498	160	LR	
<i>Aulopiformes</i>	Chlorophthalmidae	<i>Chlorophthalmus agassizi</i>	Shortnose greeneye	Éperlan du large	156	126336	78	LR	
<i>Stomiiformes</i>	Sternopychidae	<i>Maurolicus muelleri</i>	Silvery lightfish	Brossé améthyste	158	127312	52	LR	
<i>Scorpaeniformes</i>	Stomiidae	<i>Stomias boa</i>	Boa dragonfish	Dragon-boa	159	127374	20	LR	
<i>Argentiniiformes</i>	Argentinidae	<i>Argentina silus</i>	Greater argentine	Grande argentine	160	126715	963	LI	
<i>Cottidae</i>	Cottidae	<i>Myoxocephalus octodecemspinosis</i>	Longhorn sculpin	Chabosseau à dix-huit épines	300	159520	3292	LF	

Class	Order	Family	Scientific name	English name	French name	Species code	AphiaID	Num. records	Category
Perciformes	Triglidae	<i>Myoxocephalus scorpius</i>	Shorthorn sculpin	Chabosseau à épines courtes	301	127203	131	LR	
		<i>Myoxocephalus aenaeus</i>	Grubby	Chabosseau bronzé	303	159519	40	LR	
	Psychrolutidae	<i>Triglops murrayi</i>	Moustache sculpin	Faux-trigle armé	304	127205	1182	LF	
	Cottidae	<i>Artediellus uncinatus</i>	Arctic hookear sculpin	Hameçon neigeux	306	127195	306	LI	
	Hemitripteridae	<i>Cottunculus microps</i>	Polar sculpin	Cotte polaire	307	127235	29	LR	
Acanthomorpha	Gobiidae	<i>Icelus spatula</i>	Spatulate sculpin	Icèle spatulée	314	127200	40	LR	
	Gobiidae	<i>Hemitripterus americanus</i>	Sea raven	Hémithriptère atlantique	320	159518	2126	LF	
	Gobioidae	<i>Aspidophoroides monopterygius</i>	Alligatorfish	Poisson-alligator atlantique	340	159459	1029	LF	
		<i>Ulcina olrikii</i>	Arctic alligatorfish	Poisson-alligator arctique	341	274356	13	LR	
	Gobioidae	<i>Leptagonus decagonus</i>	Atlantic poacher	Agone atlantique	350	127191	266	LI	
	Gobioidae	<i>Agonidae</i>	Alligatorfishes	Poissons-alligator	351	125588	43	LR	
Lophiiformes	Lophiidae	<i>Lophius americanus</i>	Monkfish	Baudroie d'Amérique	400	159184	1970	LF	
Gadiformes	Macrouridae	<i>Nezumia bairdii</i>	Marlin-spike grenadier	Grenadier du Grand Banc	410	183289	529	LI	
		<i>Trachyrincus murrayi</i>	Roughnose grenadier	Grenadier-scie	412	126481	18	LR	
Scorpaeniformes	Cyclopteridae	<i>Cyclopterus lumpus</i>	Lumpfish	Lompe	501	127214	216	LI	

Class	Order	Family	Scientific name	English name	French name	Species code	AphiaID	Num. records	Category
			<i>Eumicrotremus spinosus</i>	Atlantic spiny lump sucker	Petite poule de mer atlantique	502	127217	226	LI
		Liparidae	<i>Liparis atlanticus</i>	Atlantic seasnail	Limace atlantique	503	159524	34	LR
			<i>Liparis fabricii</i>	Gelatinous snailfish	Limace gélatineuse	505	127218	27	LR
			<i>Liparis gibbus</i>	Variegated snailfish	Limace marbée	512	159526	41	LR
			<i>Careproctus reinhardtii</i>	Sea tadpole	Petite limace de mer	520	127212	18	LR
<hr/>									
Perciformes									
		Zoarcidae	<i>Lycenchelys verrillii</i>	Wolf eelpout	Lycode à tête longue	603	159258	40	LR
<hr/>									
Anguilliformes									
		Nemichthyidae	<i>Nemichthys scolopaceus</i>	Slender snipe eel	Avocette ruban	604	126306	28	LR
<hr/>									
Perciformes									
		Ammodytidae	<i>Ammodytes dubius</i>	Sand lance	Lançon	610	151520	1283	LI
		Zoarcidae	<i>Lycodes terraenovae</i>	Newfoundland eelpout	Lycode du Labrador	619	127117	64	LR
			<i>Lycodes lavalaei</i>	Newfoundland eelpout	Lycode du Labrador	620	127107	72	LR
		Pholidae	<i>Pholis gunnellus</i>	Rock gunnel	Sigouine de roche	621	126996	21	LR
		Stichaeidae	<i>Lumpenus lampretaeformis</i>	Snakeblenny	Lompénie-serpent	622	154675	423	LI
			<i>Leptoclinus maculatus</i>	Daubed shanny	Lompénie tachetée	623	127072	443	LI
			<i>Ulvaria subbifurcata</i>	Radiated shanny	Ulvaire deux-lignes	625	159821	145	LR
			<i>Eumesogrammus praecisus</i>	Fourline snakeblenny	Quatre-lignes atlantique	626	159817	40	LR
		Cryptacanthodidae	<i>Cryptacanthodes maculatus</i>	Wrymouth	Terrassier tacheté	630	159675	120	LR
		Callionymidae	<i>Foetorepus agassizii</i>	Spotfin dragonet	Dragonnet tacheté	637	276339	20	LR

Class	Order	Family	Scientific name	English name	French name	Species code	AphiaID	Num. records	Category
Zeiformes	Zoarcidae	Zoarcidae	<i>Zoarces americanus</i>	Ocean pout	Loquette d'Amérique	640	159267	1478	LF
			<i>Lycodes reticulatus</i>	Arctic eelpout	Lycode arctique	641	127112	70	LR
			<i>Melanostigma atlanticum</i>	Atlantic soft pout	Molasse atlantique	646	127120	43	LR
			<i>Lycodes vahlii</i>	Vahl's eelpout	Lycode à carreaux	647	127118	565	LI
	Stromateidae		<i>Peprilus triacanthus</i>	Atlantic butterfish	Stomaté fossette	701	159828	487	LI
Aulopiformes	Zeidae		<i>Zenopsis conchifer</i>	Silvery John dory	Saint Pierre argenté	704	127426	39	LR
	Paralepididae		<i>Arctozenus risso</i>	White barracudina	Lussion blanc	712	126352	196	LR
Beloniformes	Scomberesocidae	Scomberesocidae	<i>Scomberesox saurus</i>	Atlantic saury	Balaou atlantique	720	126392	37	LR
			<i>Sternopychidae</i>	Hatchetfishes	Haches d'argent	741	125603	21	LR
Lophiiformes	Ogcocephalidae	Ogcocephalidae	<i>Dibranchus atlanticus</i>	Atlantic batfish	Malthe atlantique	742	126558	18	LR
			<i>Synphurus diomedeanus</i>	Spottedfin tonguefish	Langue fil noir	816	159358	24	LR
Scorpaeniformes	Cottidae	Cottidae	<i>Artediellus atlanticus</i>	Atlantic hookear sculpin	Hameçon atlantique	880	127193	258	LI
			<i>Dipturus laevis</i>	Barndoor skate	Grande raie	200	158548	246	LI
Elasmobranchii	Rajiformes	Rajidae	<i>Amblyraja radiata</i>	Thorny skate	Raie épineuse	201	105865	3937	LF
			<i>Malacoraja senta</i>	Smooth skate	Raie lisse	202	158554	1773	LF

Class	Order	Family	Scientific name	English name	French name	Species code	AphiaID	Num. records	Category	
Squaliformes			<i>Leucoraja erinacea</i>	Little skate	Raie hérisson	203	158551	712	LI	
			<i>Leucoraja ocellata</i>	Winter skate	Raie tachetée	204	158553	1180	LF	
	Squalidae	<i>Squalus acanthias</i>	Piked dogfish	Aiguillat commun	220	105923	1985	LF		
		<i>Centroscyllium fabricii</i>	Black dogfish	Aiguillat noir	221	105906	31	LR		
Cephalopoda										
<i>Oegopsida</i>										
<i>Myopsida</i>	Ommastrephidae	<i>Illex illecebrosus</i>	Northern shortfin squid	Encornet rouge nordique	4511	153087	4836	LF		
	Loliginidae	<i>Doryteuthis pealeii</i>	Longfin inshore squid	Calmar totam	4512	574541	96	LR		
Malacostraca										
<i>Decapoda</i>										
<i>Oregoniidae</i>	Pandalidae	<i>Pandalus borealis</i>	Northern prawn	Crevette nordique	2211	107649	718	SF		
	Cancridae	<i>Cancer borealis</i>	Jonah crab	Tourteau jona	2511	158056	1387	SF		
		<i>Cancer irroratus</i>	Atlantic rock crab	Tourteau poïnclos	2513	158057	788	SF		
	Oregoniidae	<i>Hyas coarctatus</i>	Arctic lyre crab	Crabe Hyas coarctatus	2521	107323	711	SF		
	Lithodidae	<i>Lithodes maja</i>	Atlantic king crab	Crabe épineux du nord	2523	107205	531	SF		
	Oregoniidae	<i>Chionoecetes opilio</i>	Queen crab	Crabe des neiges	2526	107315	1546	SF		
		<i>Hyas araneus</i>	Great spider crab	Crabe lyre araignée	2527	107322	625	SF		
	Geryonidae	<i>Chaceon quinquedens</i>	Red deepsea crab	Crabe rouge	2532	158407	33	SR		
	Nephropidae	<i>Homarus americanus</i>	American lobster	Homard américain	2550	156134	1623	SF		

306 **2.4 Analyses**

307 The Oracle relational database where all data are stored was accessible from the Bedford
308 Institute of Oceanography in Dartmouth, Nova Scotia. Structured Query Language (SQL) is
309 used to extract the data from the production server and to create the data products used in
310 all subsequent analyses. Catch records classified as "valid" (i.e. a representative tow without
311 damage to the net) are used in the current analyses. To make the available samples comparable,
312 catch number and weight for each species was standardized for the distance towed.

313 All data processing and analyses were conducted using the R software (R Core Team 2020)
314 using packages gstat (Pebesma 2004), PBSmapping (Schnute et al. 2019), RODBC (Ripley
315 and Lapsley 2019), spatstat (Baddeley 2015), maptools (Bivand and Lewin-Koh 2020), rgeos
316 (Bivand and Rundel 2020), classInt(Bivand 2020), RColorBrewer(Neuwirth 2014), MASS (Ripley
317 et al. 2020), worms (Holstein 2018), and tidyverse (Wickham 2019). The present document is
318 rendered as a Technical Report using the csasdown R package developed and maintained by
319 Fisheries and Oceans Canada scientists (Anderson et al. In press).

320 **2.4.1 Geographic distribution of catches**

321 Spatial interpolation of catch biomass (kg/tow) or abundance (number/tow) was done using a
322 weighting inversely proportional to the distance, using function "idw" of the spatstat R package
323 (Baddeley 2015).

324 **2.4.2 Abundance and biomass indices**

325 For each species, stratified random estimates of catch abundance and biomass (Smith 1996)
326 were computed for each year. Yearly estimates of the standard error were also computed.

327 **2.4.3 Distribution indices**

328 For each Category L, I and S fish species, the minimum area required to account for 75% and
329 95% of the total biomass or abundance were computed (D75% and D95%). These measures of
330 distributions were computed for each year by using the Lorenz curve of mean stratum-level catch
331 estimates and the area of occupied strata (Swain and Sinclair 1994; Swain and Morin 1996).

332 **2.4.4 Length frequencies**

333 The length frequency distribution of catch is tabulated for each seven-year period (1970-2009),
334 and last ten-year period (2010-2020).

335 **2.4.5 Length-weight relationship and condition factor**

336 The relationship between the weight and the length of fish was estimated using the following
337 non-linear isometric relationship:

$$W = \alpha L^\beta$$

338 where W is the total weight (g), L is the length (cm), and, α and β are the parameters to be
339 estimated.

340 Average fish condition (C) was computed as:

$$C = \frac{W}{\alpha L^\beta}$$

341

342 **2.4.6 Depth, temperature and salinity distribution of catches**

343 For each category L species, We followed the methods developed by (Perry and Smith 1994)
344 and generated cumulative frequency distributions of depth, temperature and salinity of survey
345 catches.

346 **2.4.7 Density-dependent habitat selection**

347 We followed the methods of (Myers and Stokes 1989) to evaluate how fish abundance in each
348 stratum varied with overall temporal fluctuations of population abundance.

349 For each category L species, we fitted a model of the relationship between stratum-level density
350 and overall abundance (the yearly stratified random estimate of abundance, defined above).
351 To properly use the observations of zero catch while accounting for the logarithmic distribution
352 of catch abundance, we implemented the model as a generalised linear using a log link and a
353 Poisson error distribution:

$$Y_{h,i} = \alpha_h Y_i^{\beta_h}$$

354 where, $y_{h,i}$ is the average abundance of stratum h in year i , and $\alpha_{h,i}$ and $\beta_{h,i}$ are the fitted
355 parameters. The estimated parameter $\beta_{h,i}$ is referred to as the “slope parameter” and indicates
356 whether stratum-level density is positively ($\beta_{h,i} <= 0$), negatively ($\beta_{h,i} >= 0$) or negligibly
357 ($\beta_{h,i} \approx 0$) related to population abundance.

358 To estimate the suitability of each stratum, the median abundance observed during the years
359 that are in the top 25% of yearly estimates is used. We combine the slope parameter estimates
360 from the above model with the median abundance to identify strata that have consistently high
361 abundance and whose local density is weakly related to fluctuation in population abundance
362 ($\beta_{h,i} \approx 0$). Preferred strata are identified for each category L species.

363

3 Results

364 The plots generated for each species are presented in the Appendix.

365 3.1 Description of Figures

366 3.1.1 Type A

367 For Category L and S species:

368 Spatial distribution of catch-per unit of effort, (CPUE, kilograms per tow) in July-August for the
369 Bay of Fundy and Scotian Shelf in five-year periods. Spatial interpolation between tows was
370 done using Inverse Distance Weight (IDW). The probability of occurrence (proportion of tows with
371 catch records for a given species) was also reported for each five-year period.

372 For Category LR and SR:

373 Location of tows with catch over the period 1970-2012 (Type LR) or the period 1999-2012 (Type
374 SR). Location of tows with catch over the period 1970-2012 (Type LR) or the period 1999-2012
375 (Type SR).

376 3.1.2 Type B

377 For Category L, S and I species:

378 Stratified random estimate of CPUE (left panel), distribution indices (D75% and D95%, the
379 minimum area containing 75% and 95% of biomass, middle panel), and distribution vs. weight
380 per tow (right panel). The stratified random mean is plotted as a solid line with the 95%
381 confidence region indicated by the solid grey line. The overall mean is plotted as a grey
382 horizontal line and the overall mean plus or minus 50% of the standard deviation appear as
383 horizontal dashed lines. In all three panels, the early years appear in blue and the last years
384 appear in red. The predictions from a loess estimator are overlaid on the distribution indices
385 (middle panel). The Pearson correlation coefficient between D75% and biomass, and its
386 statistical significance, are also reported in the right panel.

387 3.1.3 Type C.

388 Length frequency distribution for NAFO divisions 4X and 4VW. A smoothed length frequency
389 distribution is shown for each 7-year periods covered by the surveys.

390 **3.1.4 Type D.**

391 Average fish condition for all fish lengths (black dots and black line), large fish (thick gray line),
392 and small fish (thin gray line). Fish condition is presented for NAFO divisions 4VW (right panel)
393 and 4X (left panel).

394 **3.1.5 Type E.**

395 Cumulative frequency distributions of depth, temperature and salinity at all sampled locations
396 (thick solid line) and at fishing locations with catch records (thin dashed line). The depth,
397 temperature and salinity associated with 5%, 25%, 50%, 75% and 95% of the cumulative catch is
398 shown in tabular fashion on the bottom right panel.

399 **3.1.6 Type F.**

400 Slopes estimates from the density-dependent habitat selection model (y axis) plotted versus
401 the median abundance during the top 25% of years. The red box indicates strata of particular
402 importance for a species by identifying slopes that are within a standard error from zero and that
403 are within the top 25% of median abundance. Each stratum is identified on the plot by the last
404 two digits of its number.

405 **3.2 Summary of successful tows by year and stratum**

406 There is something weird going on here, there are 2 tows with NAs for stratum, (HAM1980042
407 set 62 and HAM1982072 set 13).

<!-- Number of tows by stratum-year -->

Table 4. Number of representative tows conducted in each stratum during the period 1970 to 1991.

Stratum	NAFO Div.	Area (km ²)	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
440	4VN	3173.016	4	2	2	3	3	3	3	3	3	3	3	3	3	3	3	4	5	5	6	4	4	4
441	4VN	3434.000	4	2	2	3	3	3	1	3	3	3	3	3	3	3	3	5	5	4	4	6	5	5
442	4VN	4934.658	3	2	2	2	3	3	2	3	3	3	3	3	3	3	3	3	5	6	7	5	5	5
443	4VSW	4526.012	4	2	4	4	8	3	1	2	4	4	4	3	5	4	4	4	6	6	5	2	4	2
444	4VSW	13478.450	3	2	5	4	6	4	6	7	4	4	4	5	5	6	4	4	6	6	3	6	7	8
445	4VSW	3512.982	5	2	5	4	5	5	1	3	4	4	4	5	5	3	4	5	6	4	4	4	4	4
446	4VSW	1686.094	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	4	3	3	3	3	3	3
447	4VSW	5549.344	4	2	6	5	7	4	4	3	4	4	5	4	4	4	4	4	5	7	6	6	8	7
448	4VSW	4975.866	5	2	5	4	5	4	4	4	4	4	4	6	4	4	4	5	5	5	5	9	6	6
449	4VSW	494.496	2	2	2	2	3	2	2	2	1	2	2	2	1	2	2	2	2	2	2	2	2	2
450	4VSW	1315.222	2	2	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
451	4VSW	504.798	1	2	2	2	2	2	2	2	2	3	2	2	3	2	2	2	2	2	2	2	2	2
452	4VSW	1184.730	2	2	2	2	2	2	2	2	2	2	2	4	2	2	2	2	2	3	2	2	3	2
453	4VSW	889.406	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	3
454	4VSW	1713.566	3	2	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	2	2	2	3
455	4VSW	7286.948	7	6	7	6	7	6	6	7	7	7	7	7	7	7	7	8	8	7	7	12	10	10
456	4VSW	3279.470	5	4	6	5	5	6	4	6	6	6	6	6	7	6	6	6	6	7	6	6	10	7
457	4VSW	2784.974	2	2	2	2	3	2	2	2	2	2	3	2	2	2	2	2	2	4	2	2	4	2
458	4VSW	2259.572	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	5	5	3	3	9	8
459	4VSW	10810.232	3	2	4	4	4	4	4	4	4	4	4	4	3	4	4	6	6	5	6	5	5	5
460	4VSW	4615.296	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	4	3	3	3	3
461	4VSW	3962.836	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	2	1	2
462	4VSW	7266.344	3	3	4	3	4	4	4	4	4	4	4	4	4	4	4	4	6	5	4	4	5	5
463	4VSW	1037.068	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	3	2
464	4VSW	4453.898	4	3	5	3	3	6	5	5	5	5	5	5	5	4	5	5	5	7	6	5	5	9
465	4VSW	8183.222	6	5	5	4	5	4	5	5	5	5	5	7	6	5	5	5	5	8	8	8	12	9
466	4VSW	776.084	2	2	3	2	3	3	3	3	3	3	3	2	3	3	3	3	3	3	2	2	3	2
470	4X	3159.280	1	2	2	2	3	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	2
471	4X	3447.736	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
472	4X	4289.066	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2	4	4	6	4
473	4X	910.010	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2
474	4X	552.874	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	2	2	2	2	2	2
475	4X	535.704	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
476	4X	5075.452	2	2	2	2	2	2	3	2	2	2	1	2	2	2	2	2	2	2	4	4	4	4
477	4X	4230.688	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	5	4	4	5	5
478	4X	800.122	2	2	3	2	3	3	3	3	2	3	3	3	3	3	3	3	3	2	2	2	2	
480	4X	2249.270	4	4	4	3	3	3	4	4	3	4	3	3	4	4	4	4	4	4	4	4	8	
481	4X	6438.750	5	3	4	4	4	3	4	4	5	4	3	4	4	4	4	4	4	6	7	6	8	
482	4X	3578.228	2	1	2	2	2	2	3	2	2	3	2	2	2	2	2	2	2	3	3	3	3	
483	4X	1826.888	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
484	4X	7774.576	2	2	3	3	3	3	3	3	2	3	3	3	4	3	3	3	4	4	4	4	3	
485	4X	5432.588	2	2	2	3	3	3	3	3	3	2	3	4	3	3	3	3	6	7	6	2	3	
490	4X	2063.834	2	2	2	2	2	3	3	3	3	2	3	3	3	3	3	3	3	4	4	4	4	
491	4X	2359.158	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	3	
492	4X	3729.324	3	2	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	3	
493	4X	1830.322	1	2	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3	
494	4X	1431.978	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
495	4X	2005.456	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	
		171809.888	134	110	146	134	153	143	135	144	141	147	145	150	150	146	143	152	171	188	177	170	213	189

Table 5. Number of representative tows conducted in each stratum during the period 1992 to 2013.

Stratum	NAFO Div.	Area (km2)	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
440	4VN	3173.016	4	3	4	4	4	4	4	4	6	4	4	4	4	4	4	4	3	4	4	5	4	4
441	4VN	3434.000	5	5	5	5	5	5	6	7	6	6	7	6	7	6	6	5	6	6	7	6	6	6
442	4VN	4934.658	6	5	6	6	6	6	7	6	6	5	6	7	5	5	5	5	5	6	5	6	6	6
443	4VSW	4526.012	4	3	3	4	4	5	5	4	5	4	5	5	5	5	5	5	4	4	4	4	5	5
444	4VSW	13478.450	8	9	6	8	8	7	8	8	9	10	9	9	9	8	10	8	6	9	11	13	9	8
445	4VSW	3512.982	4	5	7	4	4	4	3	3	6	5	5	5	5	6	5	4	3	3	3	4	3	3
446	4VSW	1686.094	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3	4	3
447	4VSW	5549.344	7	7	7	7	6	7	7	6	7	7	7	7	7	7	6	6	4	6	6	8	6	7
448	4VSW	4975.866	6	7	7	7	6	7	6	7	8	8	8	8	7	8	8	6	5	7	7	10	8	8
449	4VSW	494.496	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	4	2	2
450	4VSW	1315.222	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
451	4VSW	504.798	2	2	2	2	4	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2
452	4VSW	1184.730	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
453	4VSW	889.406	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	1	2	2	1	3
454	4VSW	1713.566	2	2	2	2	3	2	2	2	2	2	2	2	2	3	2	2	2	2	2	4	2	2
455	4VSW	7286.948	10	9	10	10	10	13	8	11	11	11	11	11	8	12	11	7	5	8	8	10	10	11
456	4VSW	3279.470	7	8	8	8	8	8	6	8	10	8	8	8	8	8	8	6	2	7	7	9	8	8
457	4VSW	2784.974	2	2	2	2	2	2	2	1	4	2	2	2	2	2	2	2	2	2	2	4	2	2
458	4VSW	2259.572	8	8	8	8	7	8	5	6	10	8	7	8	8	10	8	5	2	7	6	9	8	6
459	4VSW	10810.232	6	4	6	6	4	5	5	6	6	8	6	6	6	6	6	5	3	6	6	7	6	6
460	4VSW	4615.296	3	3	3	3	3	3	3	3	3	3	3	3	3	4	3	3	2	3	3	4	4	3
461	4VSW	3962.836	2	2	2	2	2	2	2	2	2	2	2	2	2	2	4	2	2	2	2	3	3	2
462	4VSW	7266.344	4	4	4	4	4	4	4	4	4	4	4	4	4	5	4	4	3	4	4	4	6	4
463	4VSW	1037.068	2	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	3	2	2
464	4VSW	4453.898	7	7	7	7	7	4	7	7	7	7	7	7	5	8	7	6	4	5	6	7	7	7
465	4VSW	8183.222	10	10	10	10	10	10	9	10	10	10	10	10	10	10	10	7	8	7	8	10	10	10
466	4VSW	776.084	2	2	2	3	2	2	3	2	2	2	2	2	2	2	2	2	1	3	2	2	2	2
470	4X	3159.280	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3
471	4X	3447.736	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3
472	4X	4289.066	4	4	4	4	4	3	4	4	4	4	4	4	4	4	4	4	3	4	3	4	6	4
473	4X	910.010	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
474	4X	552.874	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
475	4X	535.704	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
476	4X	5075.452	4	4	4	4	4	4	4	4	4	4	4	4	5	4	4	4	4	4	4	4	4	4
477	4X	4230.688	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	5
478	4X	800.122	2	2	2	3	3	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
480	4X	2249.270	8	8	8	8	8	8	8	8	7	8	8	8	7	9	8	6	8	8	8	7	8	
481	4X	6438.750	9	9	9	9	7	9	9	9	8	9	8	9	9	6	12	9	7	8	8	8	10	9
482	4X	3578.228	3	3	3	3	3	3	3	3	3	3	3	3	3	2	4	3	3	3	3	4	3	3
483	4X	1826.888	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	2
484	4X	7774.576	3	3	3	3	3	3	3	3	3	3	3	3	3	4	3	3	4	3	3	5	5	5
485	4X	5432.588	3	3	3	3	3	3	3	3	3	4	3	5	5	3	2	5	4	5	5	6	5	5
490	4X	2063.834	4	4	4	5	4	4	4	3	4	4	4	4	6	4	3	3	3	4	3	3	4	2
491	4X	2359.158	3	3	3	3	3	3	3	3	3	3	3	3	3	5	3	3	4	3	4	4	4	4
492	4X	3729.324	3	3	3	2	3	3	3	3	3	3	3	3	5	2	3	4	4	4	4	4	6	4
493	4X	1830.322	3	3	3	3	2	3	3	2	3	3	4	5	2	4	4	3	3	4	3	4	4	4
494	4X	1431.978	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	4	4	4	4
495	4X	2005.456	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	5	3	3	4	3	4	4
171809.888			193	190	195	195	191	193	186	191	213	201	208	216	188	222	209	177	165	196	196	243	210	208

Table 6. Number of representative tows conducted in each stratum during the period 2014 to 2020 and for the whole 1970 to 2020 period.

Stratum	NAFO Div.	Area (km2)	2014	2015	2016	2017	2018	2019	2020	Total
440	4VN	3173.016	4	4	4	4	0	5	4	190
441	4VN	3434.000	6	6	6	6	0	7	4	238
442	4VN	4934.658	6	6	6	6	0	6	5	240
443	4VSW	4526.012	3	7	4	5	0	9	4	214
444	4VSW	13478.450	9	9	11	10	0	6	8	352
445	4VSW	3512.982	3	4	4	4	0	6	3	215
446	4VSW	1686.094	3	2	3	2	0	3	2	145
447	4VSW	5549.344	7	7	7	7	0	6	5	291
448	4VSW	4975.866	8	7	6	6	0	7	4	299
449	4VSW	494.496	2	2	2	2	0	2	2	100
450	4VSW	1315.222	3	3	3	2	0	3	2	144
451	4VSW	504.798	2	2	2	2	0	2	2	104
452	4VSW	1184.730	1	4	3	3	0	3	3	110
453	4VSW	889.406	3	2	2	1	0	2	2	116
454	4VSW	1713.566	2	2	2	2	0	3	2	121
455	4VSW	7286.948	11	9	9	8	0	9	6	429
456	4VSW	3279.470	6	5	6	6	0	6	4	331
457	4VSW	2784.974	2	3	3	3	0	3	2	113
458	4VSW	2259.572	4	5	5	5	0	6	3	269
459	4VSW	10810.232	6	7	7	6	0	9	7	262
460	4VSW	4615.296	3	5	5	5	3	6	5	151
461	4VSW	3962.836	2	3	3	3	2	3	3	113
462	4VSW	7266.344	5	5	5	5	0	5	5	212
463	4VSW	1037.068	2	3	2	2	0	2	2	107
464	4VSW	4453.898	7	6	6	4	0	6	4	288
465	4VSW	8183.222	10	10	9	7	3	10	7	397
466	4VSW	776.084	2	2	2	3	0	3	2	118
470	4X	3159.280	2	3	3	3	4	3	2	112
471	4X	3447.736	2	3	3	3	4	4	3	110
472	4X	4289.066	4	4	4	4	4	4	4	172
473	4X	910.010	2	2	2	2	2	2	2	104
474	4X	552.874	2	2	2	2	2	2	2	100
475	4X	535.704	2	2	2	2	2	2	2	103
476	4X	5075.452	4	5	5	5	5	5	5	177
477	4X	4230.688	6	5	5	4	4	6	4	204
478	4X	800.122	2	2	2	3	2	2	2	119
480	4X	2249.270	6	7	7	7	5	7	5	306
481	4X	6438.750	9	8	10	9	6	9	6	350
482	4X	3578.228	3	3	4	4	3	4	3	141
483	4X	1826.888	2	2	3	3	2	3	2	105
484	4X	7774.576	4	6	5	7	7	7	7	186
485	4X	5432.588	5	6	6	6	4	6	5	196
490	4X	2063.834	3	4	4	4	3	4	3	173
491	4X	2359.158	4	4	4	4	3	4	3	168
492	4X	3729.324	4	3	4	4	3	4	4	171
493	4X	1830.322	3	3	4	6	3	3	3	159
494	4X	1431.978	3	4	4	3	2	4	3	128
495	4X	2005.456	2	4	4	4	3	4	3	127
		171809.888	196	212	214	208	81	227	175	9080

409 A total of 9080 representative tows were conducted for the period spanning from 1970 to 2020.

410

4 Discussion

411 This report builds on previous work and former atlases by updating a comprehensive suite of
412 indices to give a snapshot of population status and environmental preferences of 104 fish and
413 invertebrate species. The current document is not meant to replace stock assessments, species-
414 specific analyses of abundance, biomass and distribution, or any targeted attempts to integrate
415 information about species or group of species from the wide and disparate sources of data about
416 marine organisms in the area covered by the DFO Maritimes summer trawl survey. It is rather
417 meant to provide a reproducible set of tools to extract and visualize the information collected
418 in the summer groundfish research vessel survey. It is hoped that this document can provide a
419 stepping stone to conduct other ecological analyses using the trawl survey data and increase
420 reproducibility and transparency of ecological information collected annually.

421 **4.1 Diversity of approaches used for mapping fish and invertebrates in the Scotian Shelf
422 bioregion**

423 Different methods have been applied in the Northwest Atlantic, and specifically on the Scotian
424 Shelf bioregion, to map fish and invertebrate species distribution. The present report, for
425 example, builds upon the atlas of important habitat developed to map the persistence of relatively
426 high biomass for key fish species using the summer groundfish research vessel survey (Horsman
427 and Shackell 2009). Important habitat was obtained by interpolating observed weight per each
428 species using the IDW, and calculating areas with relatively persistent high biomass for periods
429 representing different fishery management eras. To compliment information from this atlas,
430 including additional representations of biomass and diversity, a similar IDW interpolation mapping
431 procedure was followed by Smith et al. (2015), Ward-Paige and Bundy (2015), and Bundy et al.
432 (2017). The summer groundfish research vessel survey is typically conducted during the month
433 of July. However, from the fall of 1978 through to the spring of 1985, DFO also conducted spring
434 and fall surveys using the same sampling design. This unique seasonal data was used to map
435 the seasonal spatial distribution of key demersal and other fish species using IDW interpolation
436 on the Scotian Shelf from the spring, summer and fall between 1978 and 1985 (Smith et al.
437 2015). Following recommendations provided by Kenchington and Kenchington (2017), the spatial
438 distribution of three indicators of biodiversity for fish and invertebrates were mapped using IDW
439 interpolation to identify areas with persistently high values across fishery management eras,
440 and compared with areas of persistently high abundance for selected species (Ward-Paige and
441 Bundy 2015). This analysis revealed a lack of consistent relationships between areas of persist
442 high diversity and persistent high biomass, suggesting that both can be used as independent
443 and important spatial indicators of the system (Ward-Paige and Bundy 2015). Groupings of
444 fishes and invertebrates based on size, habitat and feeding guild, were also mapped using
445 IDW interpolations to identify hotspots of functional group diversity (Bundy et al. 2017). This
446 analysis revealed a spatially and temporally variable distribution of functional diversity across
447 the Scotian Shelf with notable areas of high and low diversity (Bundy et al. 2017). Top quintiles
448 of each functional group using the IDW approach were used as representative layers for fish

449 and invertebrates in the MPA Network design in the Scotian Shelf Bioregion (Serdynska et al. In
450 press). IDW interpolation methods have also been used to map the distribution of individual
451 species such as sea cucumbers (*Cucumaria frondosa*) in the Scotian Shelf bioregion (Shackell et
452 al. 2013a), and sea scallop (*Placopecten magellanicus*) in Georges and Browns Bank (Shackell
453 et al. 2013b).

454 Species Distribution Modelling (SDM), instead of IDW, can also be used to evaluate spatio-
455 temporal dynamics by predicting and understanding past, present and future distribution
456 of species using environmental predictors (Robinson et al. 2017). A variety of modelling
457 approaches are being implemented in Maritimes Region to map and predict fish and invertebrate
458 species distribution by incorporating environmental predictors to account for seasonal and
459 temporal variability. For example, a stock assessment of snow crab (*Chionoecetes opilio*) on
460 the Scotian Shelf used data from the snow crab survey from 2005 to 2018 to map spatial data
461 products for this stock, including annual predicted interpolations of potential habitat using
462 Generalized Additive Models (GAM) and several environmental covariates including depth,
463 curvature, slope, species composition, and annual temperature (Zisserson et al. 2019). Sea
464 scallop predicted habitat using Maximum Entropy (MaxEnt) models were computed in the
465 German Bank using data compiled via benthic habitat mapping and seafloor geotechnical
466 surveys in 2006, 2009, and 2010 (Brown et al. 2012). Predictions in the Scotian Shelf bioregion
467 and the Northeast United States using datasets from DFO and the National Oceanic and
468 Atmospheric Administration from 1993 to 2012 also predicted sea scallop habitat at a wider scale
469 based on three scenarios of seasonal temperature and salinity climatologies (NOAA) (Lowen
470 et al. 2019). Offshore American lobster stock assessments (*Homarus americanus*) used data
471 from the RV, DFO Georges Bank, and National Marine Fisheries Service (NMFS) Northeast
472 Fisheries Science Center (NEFSC) bottom trawl surveys (1970 to 2015) to predict species
473 distribution using boosted regression trees and several environmental predictors (bathymetry,
474 slope, curvature, and annual temperature interpolations) (Cook et al. 2017). Information on
475 the potential for recovery of cusk (*Brosme brosme*) used data from the bottom longline Halibut
476 industry survey and Cusk absences in the Summer groundfish research vessel survey from
477 1998-2013 to predict suitable habitat using GAM, MaxEnt, and random forest models and
478 several physical environmental variables (e.g. complexity, benthic current stress and complexity,
479 temperature, salinity, primary production, chlorophyll, suspended matter) (Harris et al. 2018).
480 Atlantic halibut (*Hippoglossus hippoglossus*) assessments using Summer groundfish research
481 vessel survey and NOAA survey data from 2001 to 2013 predicted juvenile habitat using MaxEnt
482 model and environmental predictors (bathymetry, slope, bottom temperature) (French et al.
483 2018). Persistent areas of high Atlantic halibut juvenile abundance were predicted using data
484 from 27 bottom trawl surveys combined (NMFS and DFO) from 1978 to 2013 and applying
485 Bayesian hierarchical spatiotemporal models with two environmental predictors (depth and
486 temperature) (Boudreau et al. 2017).

487 These examples of mapping efforts in Maritimes Region showcase the diversity of approaches
488 relevant to a variety of important research questions and management applications. Approaches,
489 methods, datasets, and environmental predictors are selected based on individual project
490 research questions, and considerations for each species, communities or stock. This allows
491 research groups to maintain innovation and keep up with emerging methods and technologies to
492 improve assessments, predictions, and ultimately, science advice. The diversity of approaches
493 also leads to complexity when looking across studies as each data compilation and predictive
494 method carries its own independent assumptions and can lead to different spatial outputs.

495 **4.2 Interpreting spatial results for marine spatial planning purposes**

496 Fisheries and Oceans Canada is leading a marine spatial planning process that brings together
497 relevant authorities and stakeholders to better coordinate how we use and manage marine
498 spaces to achieve ecological, economic and social objectives. Operationalizing marine spatial
499 planning includes a series of steps, including the process of analyzing existing conditions
500 by collecting and mapping information about ecological, environmental and oceanographic
501 conditions (Ehler and Douvere 2009; Agardy et al. 2011). Mapping the distribution of species
502 is critical for the implementation of spatial management and as a first step in marine spatial
503 planning processes. Species distribution have supported the identification of important sites for
504 a given species or areas of high richness and diversity, which in turn can be used to inform siting
505 decisions of new activities such as Marine Protected Areas (MPA), aquaculture sites or wind
506 turbines. In the Scotian Shelf bioregion, mapping species distributions has been used to highlight
507 areas of high biological diversity to support the identification of Ecologically or Biologically
508 Significant Areas [Ricard and Shackell (2013); Ward-Paige and Bundy (2015)], to distinguish
509 important and persistent habitat of significant species and functional groups to support MPA and
510 conservation planning (Horsman and Shackell 2009; Smith et al. 2015; Ward-Paige and Bundy
511 2015; Bundy et al. 2017), to identify important habitat for Species at Risk (Harris et al. 2018) and
512 to highlight reserves for data-poor invertebrate fisheries (Shackell et al. 2013a). Mapping species
513 distribution has also been used to illustrate multi-decadal scale projections of changes in species
514 distribution in the context of climate change and adaption (Stanley et al. 2018; W. et al. 2019).

515 In support of the marine spatial planning process, a public web-based atlas with relevant
516 geospatial information is being developed to support decision-making. This Atlantic Canada-
517 wide compilation of data and information will be a web-based, public platform with interactive
518 maps of ocean ecosystems, human uses and management areas. This atlas cannot host the
519 vast diversity of products and mapping approaches available in Maritimes Region. Consequently,
520 we recommend that data products presented in this report should not be used for the atlas until
521 an evaluation of the spatial information available and used in the past, is conducted.

522 This diverse portfolio of approaches and applications is not unique to the Maritimes Region. A
523 recent review of global distribution modelling efforts recommended the adoption of a consistent
524 framework that integrates multi-model approaches and a clear expression of errors and
525 uncertainties (Robinson et al. 2017). In this context, Pacific Region has developed two initiatives
526 to enable consistency and frequent publication, reproducibility, and transparency. One initiative
527 developed a fully automated reproducible report to give a synthesis of data availability, population
528 trends, fishing trends, growth and maturity patterns for 113 groundfish species in British
529 Columbia to support stock assessment (Anderson et al. 2019). The second initiative developed
530 a SDM framework that was applied to twelve species on Canada's Pacific coast as part of the
531 Regional Response Plan (Nephin et al. 2019). The Maritimes and Gulf region, through this and
532 past reports, are also using similar reproducible approaches to facilitate annual updates and
533 transparency (Ricard and Shackell 2013; Ricard and Gomez 2021).

534 Recognizing the diversity of approaches for mapping fish and invertebrates in the Scotian Shelf
535 bioregion, we recommend the development of a regional community of practice to compare
536 and evaluate approaches for mapping, interpolating and/or modelling fish and invertebrates
537 so future publications and advice related to spatial outputs can lead to more comparable work
538 and consistent science advice to support processes such as marine spatial planning. At the

539 international level, guidelines and standards related to appropriate variables and methods
540 for mapping and modeling species and communities of deep-sea habitats were proposed to
541 encourage the production of publications that will lead to more comparable work (Kenchington et
542 al. 2019). Similar general guidance for group practice approach mapping would be a worthwhile
543 product in Maritimes Region. Until then, we proposed the use of the Open Data record (DFO
544 2021) for the version 1.0 of the public web-based atlas.

545

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548 support of this report. The efforts of the Gulf Region secondary publications coordinators Alicia
549 Cassidy and Jeff Clements in getting this report published are well appreciated.

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7 Appendix

704

7.1 Atlantic cod (*Morue franche*) - species code 10 (category LF)

705

Scientific name: [Gadus morhua](#)

706

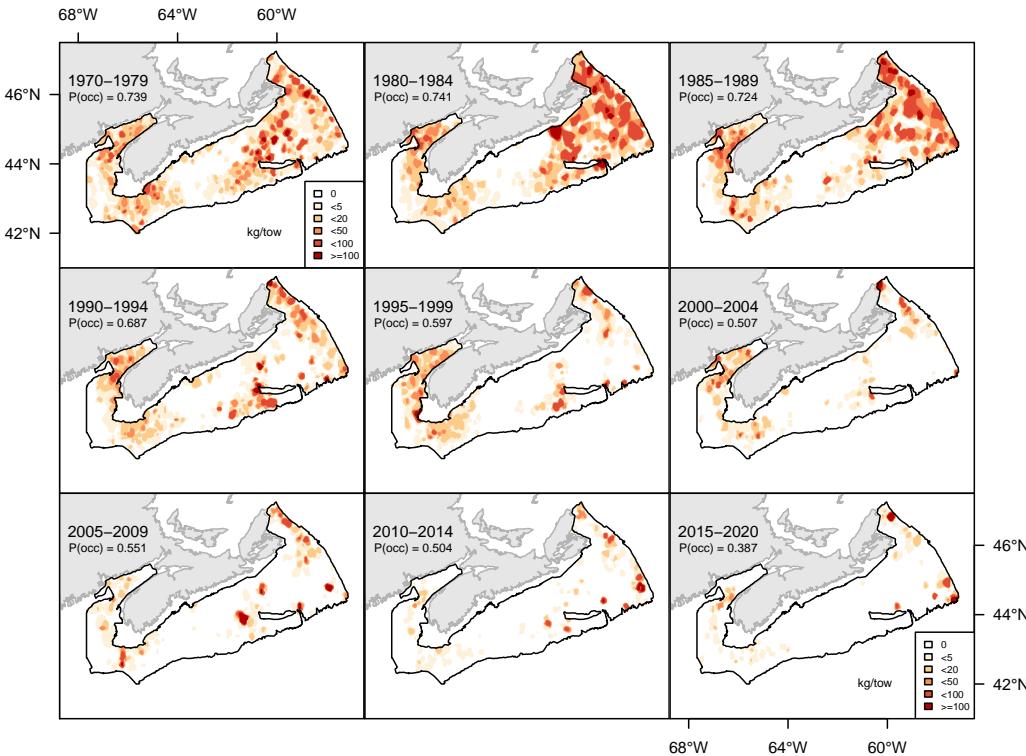


Figure 7.1A. Inverse distance weighted distribution of catch biomass (kg/tow) for Atlantic cod.

707

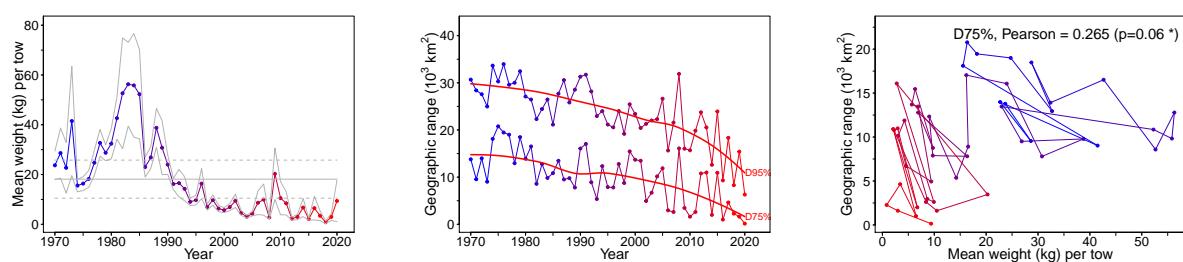


Figure 7.1B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Atlantic cod.

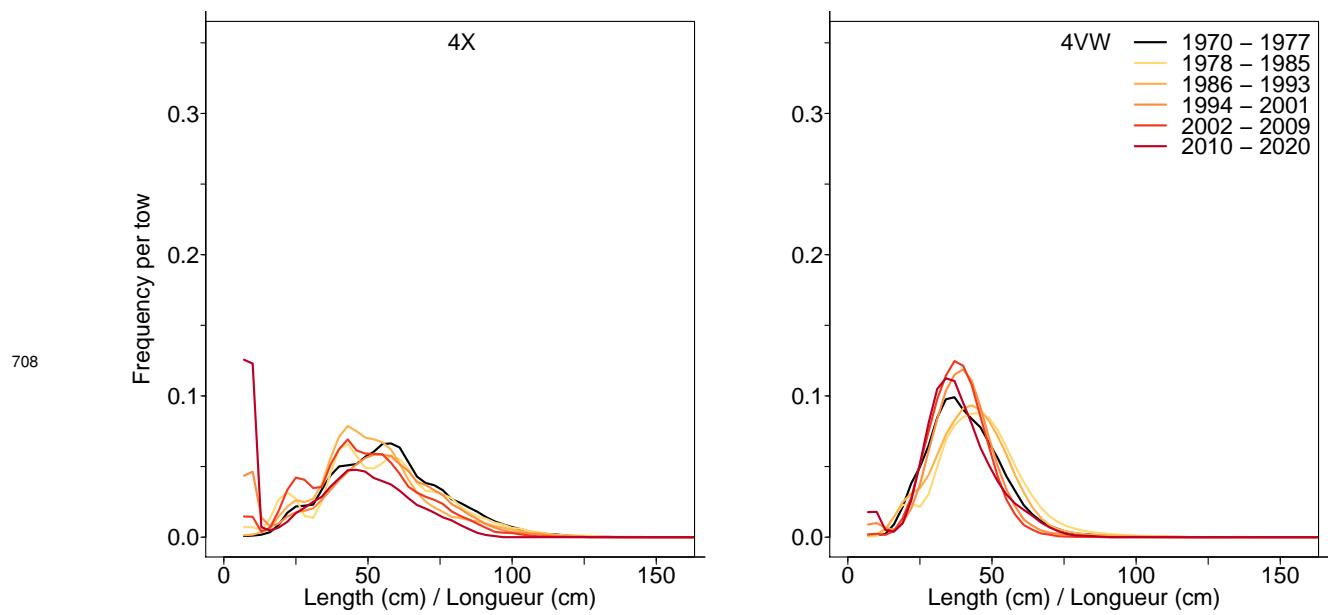


Figure 7.1C. Length frequency distribution in NAFO units 4X and 4VW for Atlantic cod.

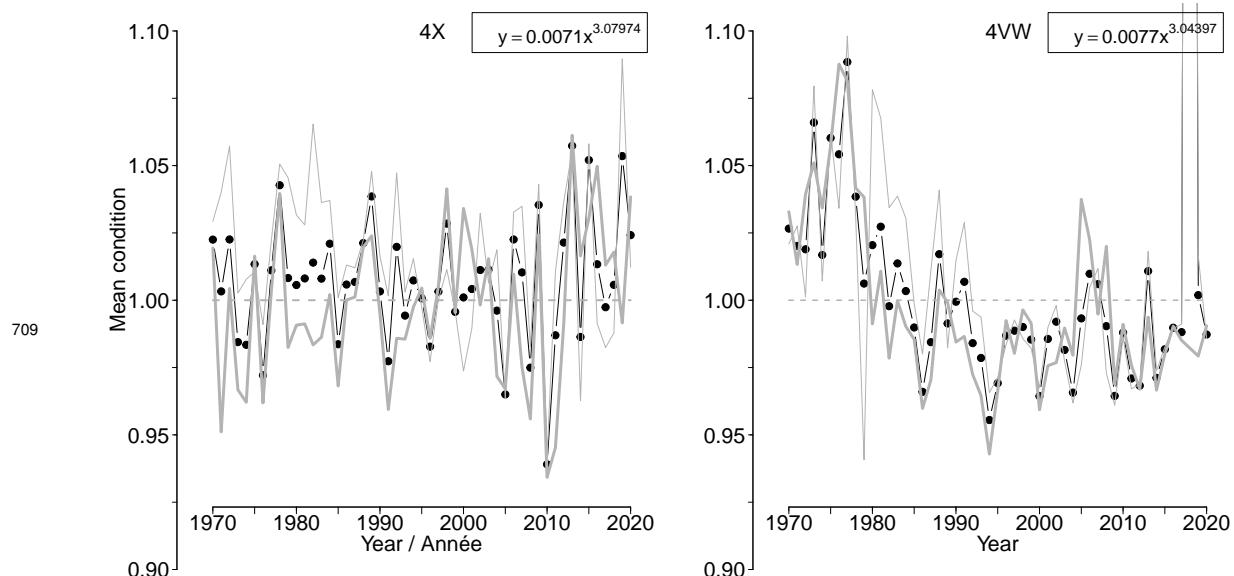
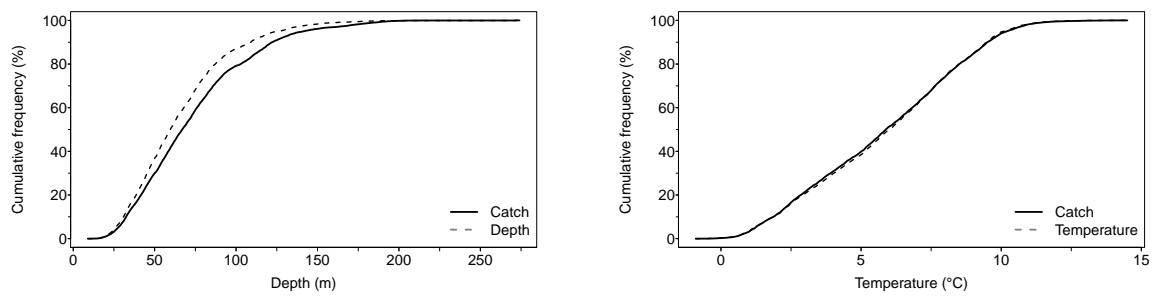
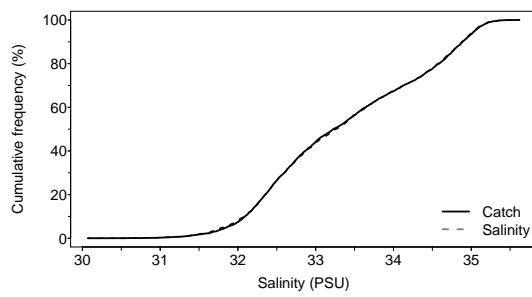


Figure 7.1D. Average fish condition in NAFO units 4X and 4VW for Atlantic cod.



710



Freq	Depth	Temp	Sal
F5	26	1.2	31.00
F25	43	3.5	32.47
F50	60	6.0	33.27
F75	82	8.1	34.40
F95	126	10.0	35.03

Figure 7.1E. Catch distribution by depth, temperature and salinity of Atlantic cod.

711

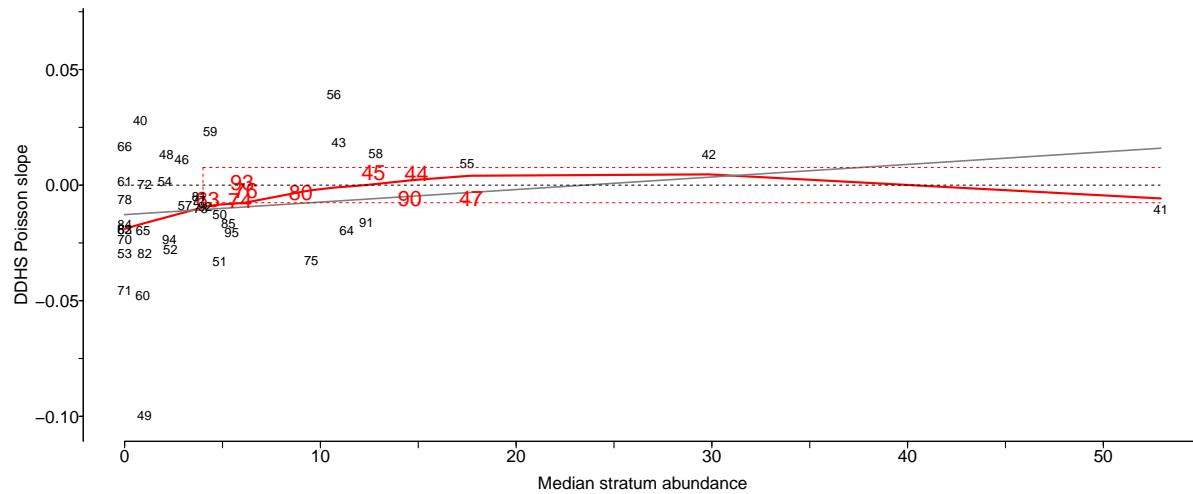


Figure 7.1F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Atlantic cod.

712

7.2 Haddock (Aiglefin) - species code 11 (category LF)

713

Scientific name: [Melanogrammus aeglefinus](#)

714

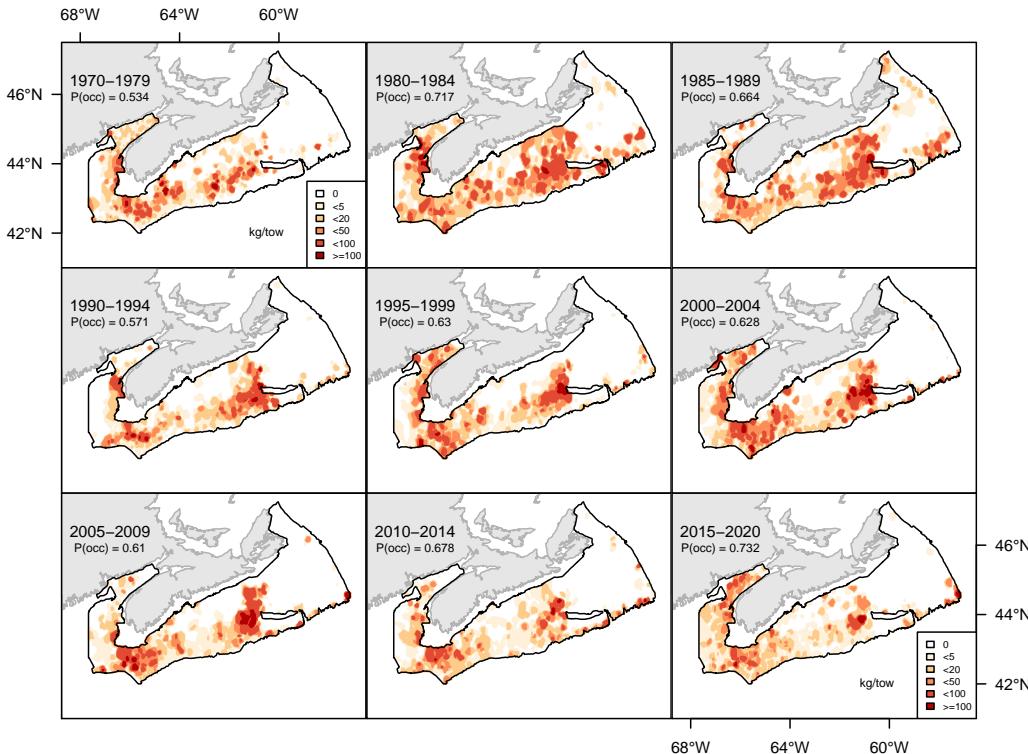


Figure 7.2A. Inverse distance weighted distribution of catch biomass (kg/tow) for Haddock.

715

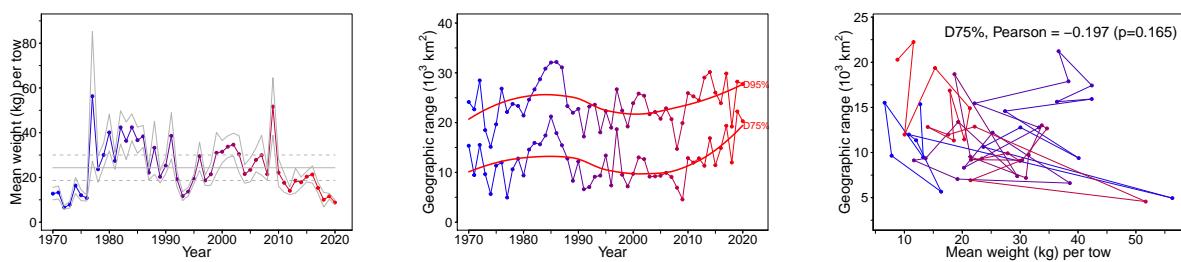


Figure 7.2B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Haddock.

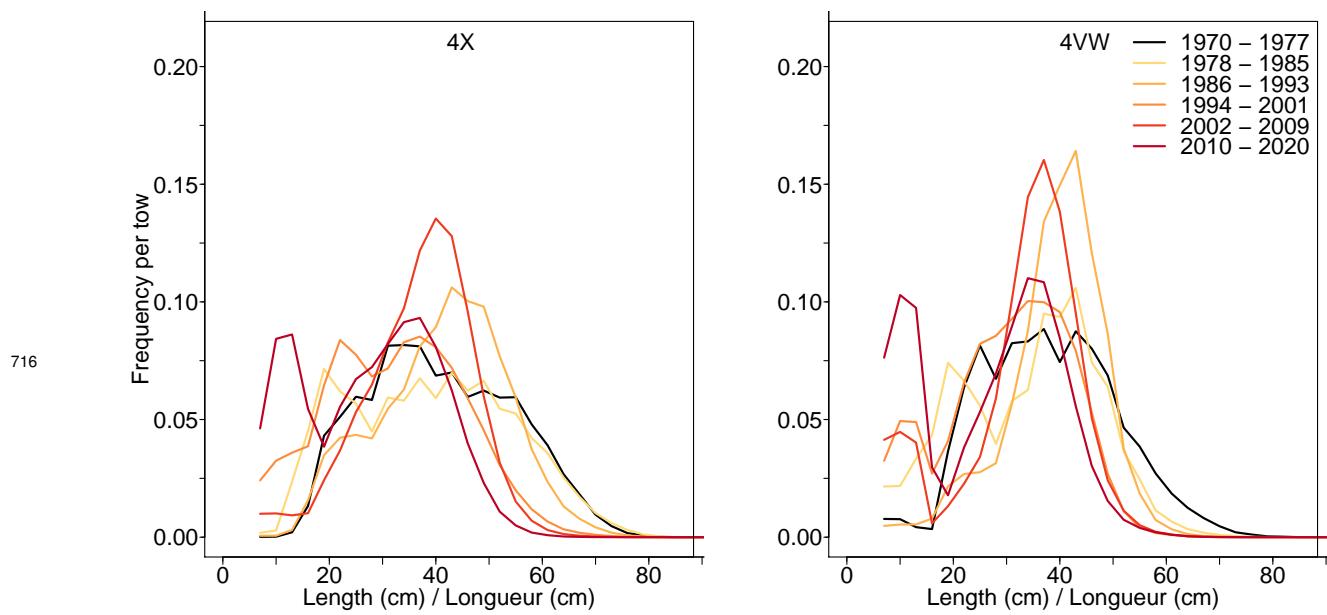


Figure 7.2C. Length frequency distribution in NAFO units 4X and 4VW for Haddock.

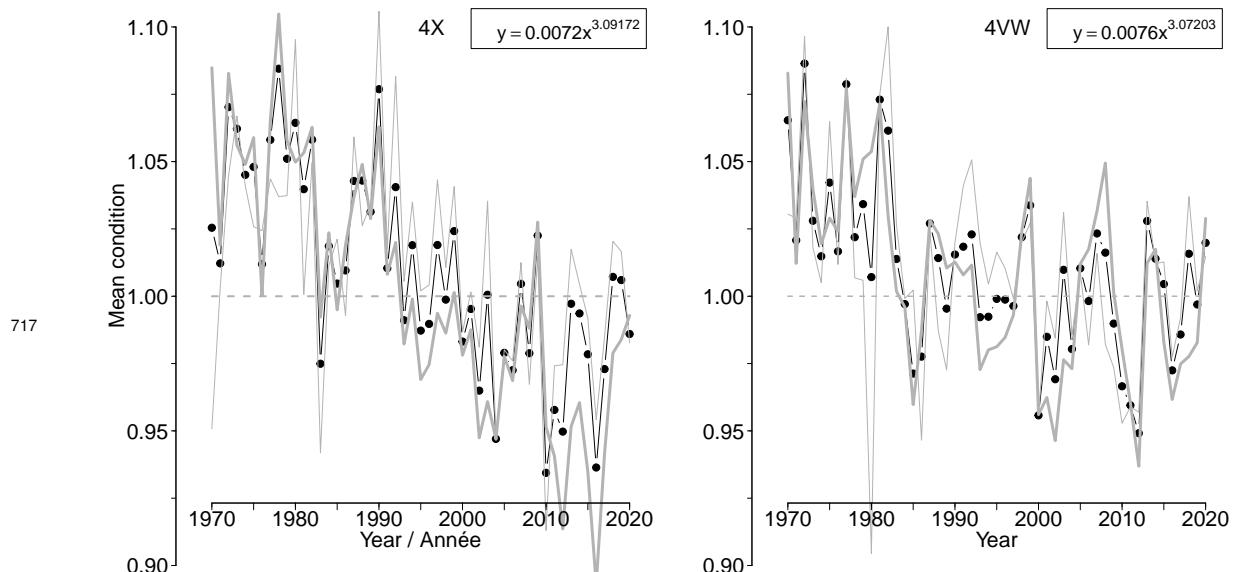
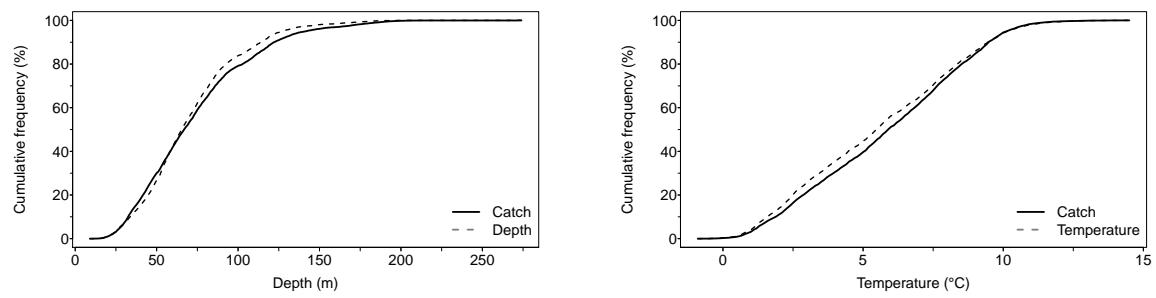
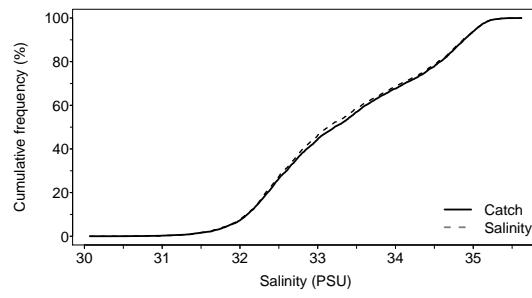


Figure 7.2D. Average fish condition in NAFO units 4X and 4VW for Haddock.



718



Freq	Depth	Temp	Sal
F5	27	1.1	31.00
F25	49	3.0	32.45
F50	66	5.5	33.14
F75	87	7.9	34.36
F95	127	10.0	35.03

Figure 7.2E. Catch distribution by depth, temperature and salinity of Haddock.

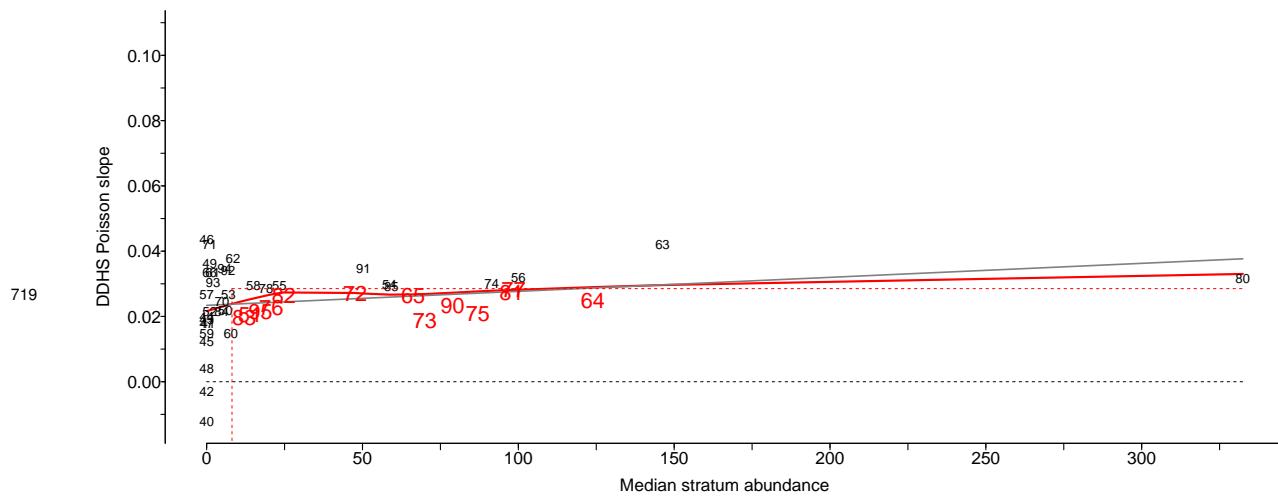


Figure 7.2F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Haddock.

720

7.3 White hake (Merluche blanche) - species code 12 (category LF)

721

Scientific name: [Urophycis tenuis](#)

722

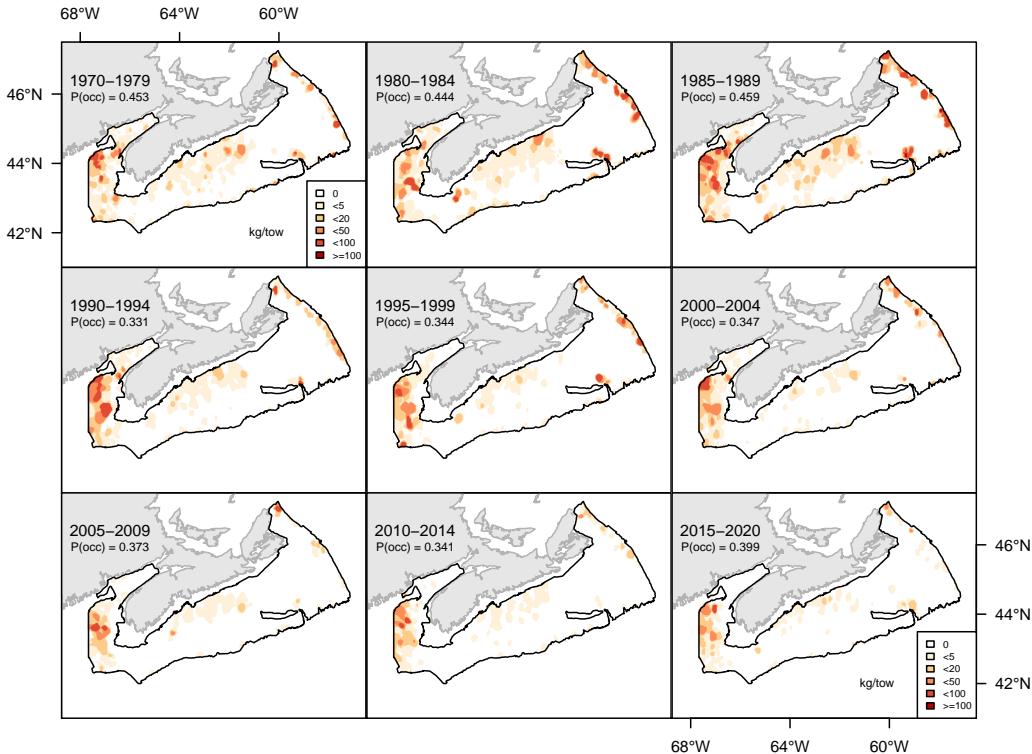


Figure 7.3A. Inverse distance weighted distribution of catch biomass (kg/tow) for White hake.

723

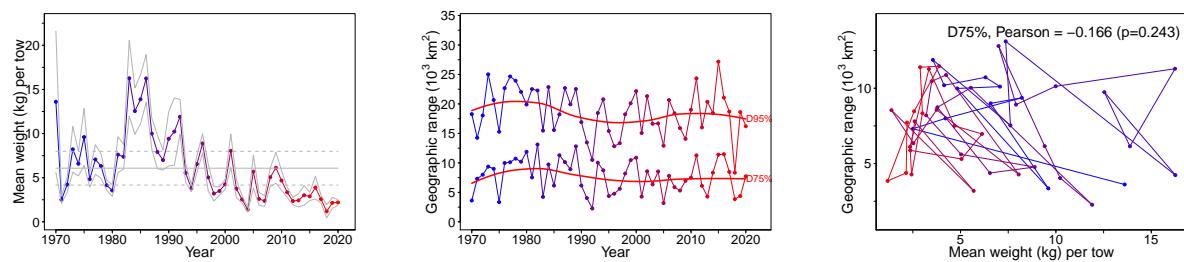


Figure 7.3B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of White hake.

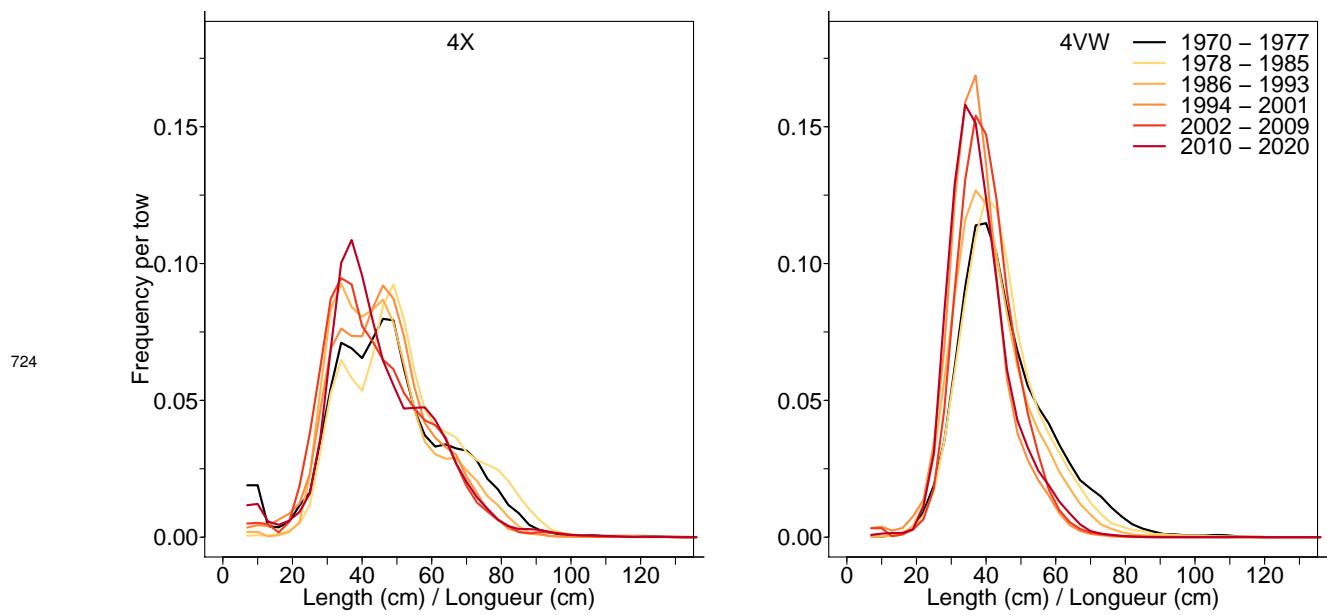


Figure 7.3C. Length frequency distribution in NAFO units 4X and 4VW for White hake.

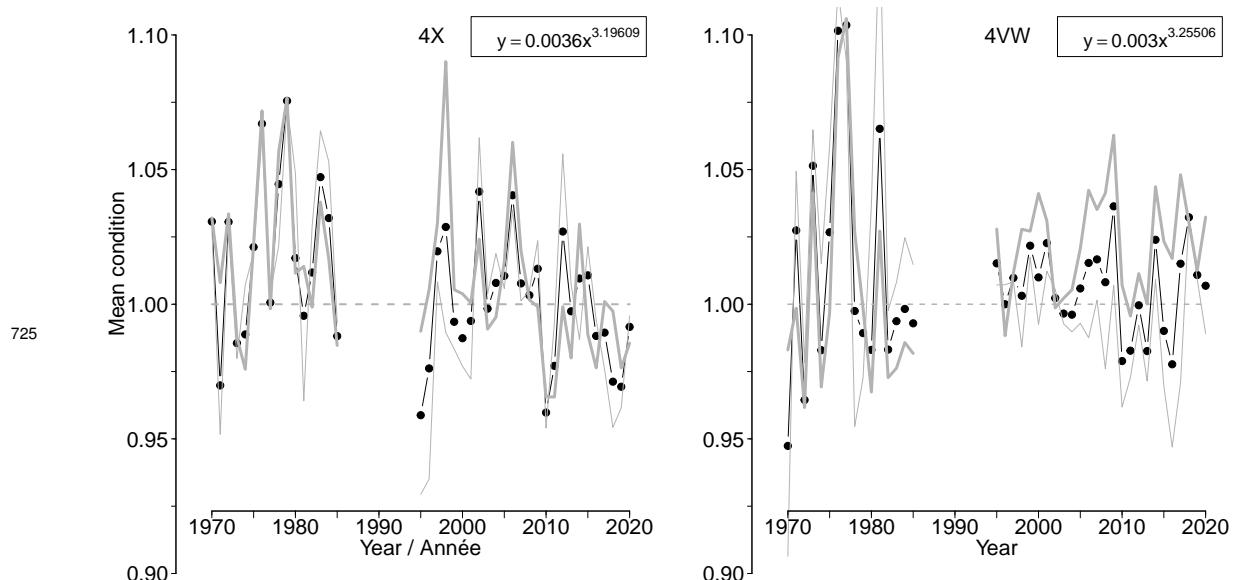
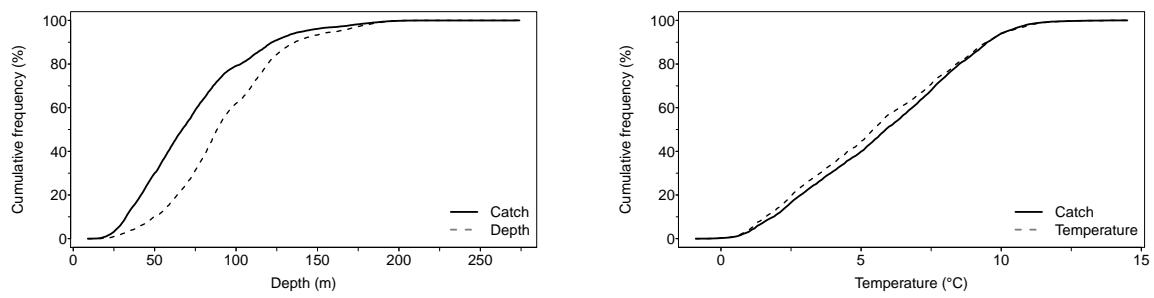
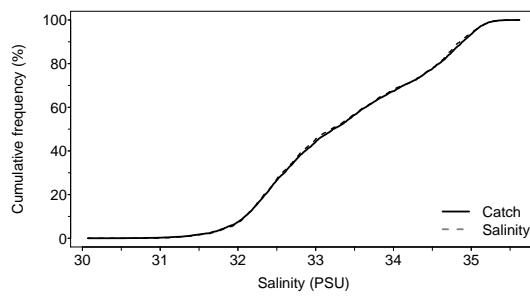


Figure 7.3D. Average fish condition in NAFO units 4X and 4VW for White hake.



726



Freq	Depth	Temp	Sal
F5	40	1.1	31.00
F25	70	3.0	32.46
F50	89	5.5	33.20
F75	115	7.9	34.39
F95	163	10.0	35.04

Figure 7.3E. Catch distribution by depth, temperature and salinity of White hake.

727

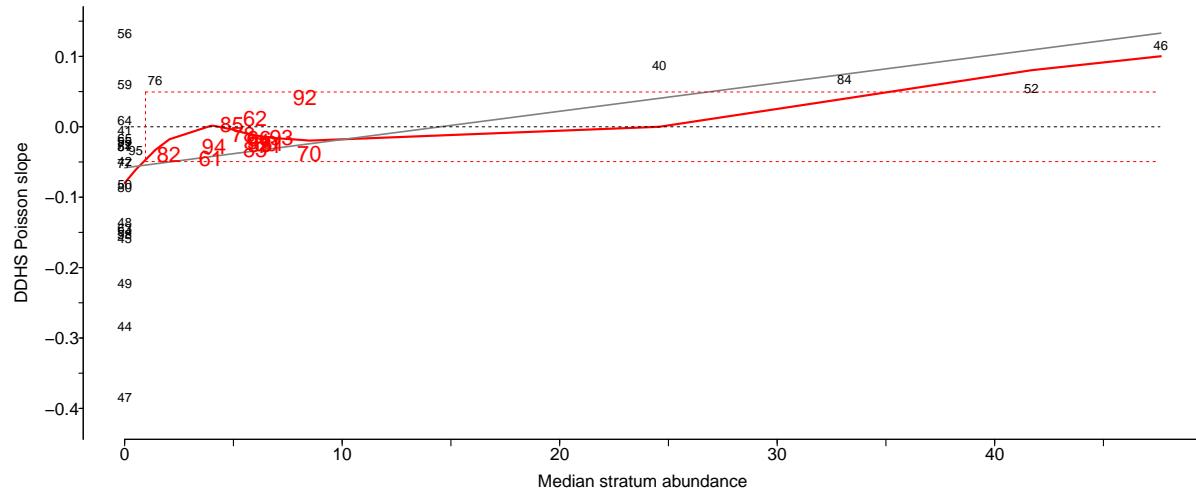


Figure 7.3F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for White hake.

728

7.4 Red hake (Merluche écureuil) - species code 13 (category LF)

729

Scientific name: [Urophycis chuss](#)

730

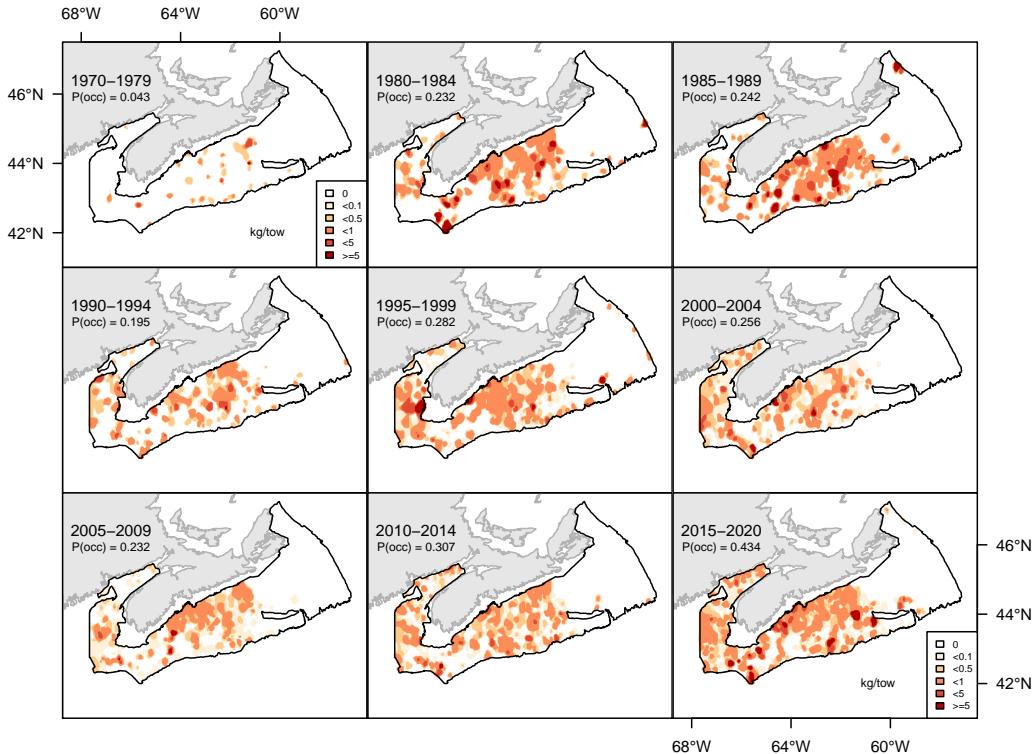


Figure 7.4A. Inverse distance weighted distribution of catch biomass (kg/tow) for Red hake.

731

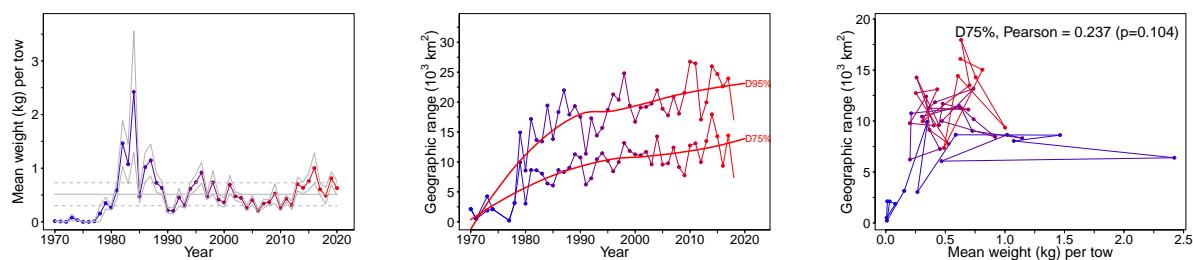


Figure 7.4B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Red hake.

732

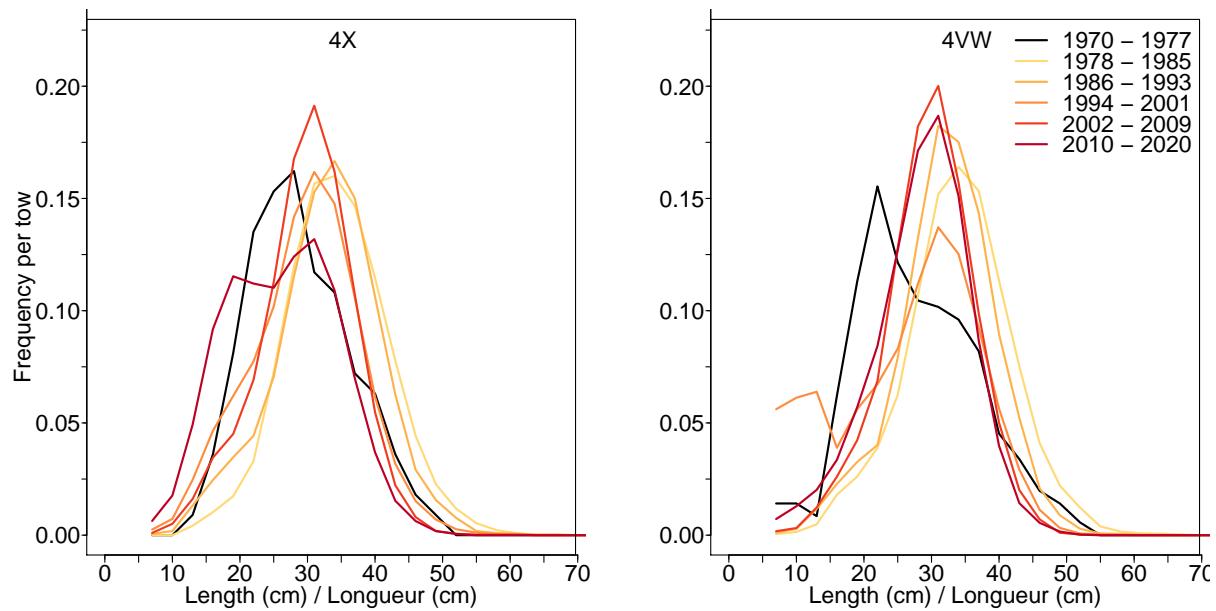


Figure 7.4C. Length frequency distribution in NAFO units 4X and 4VW for Red hake.

733

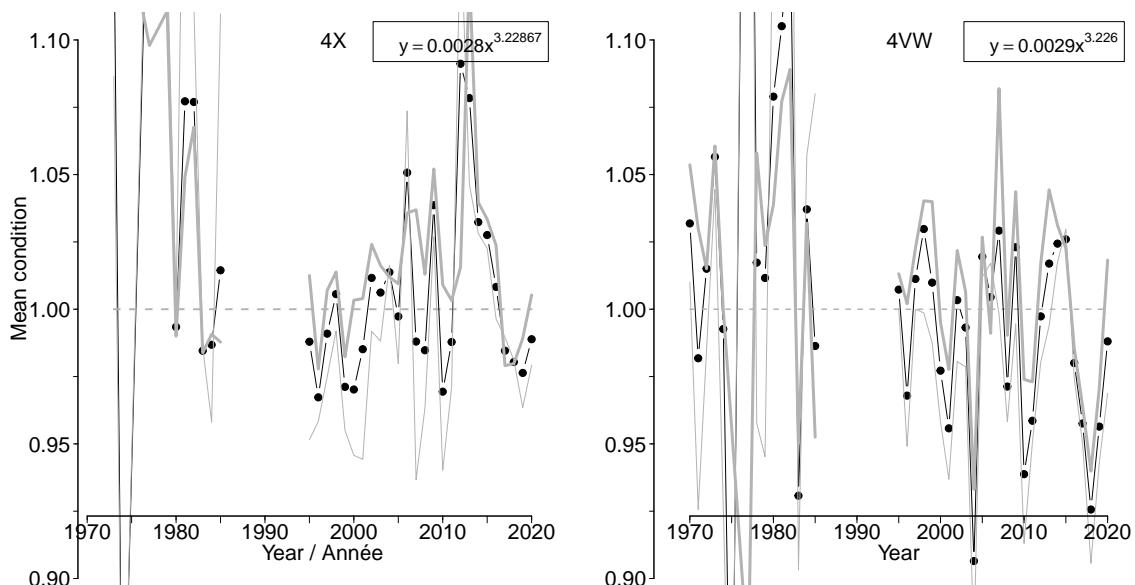
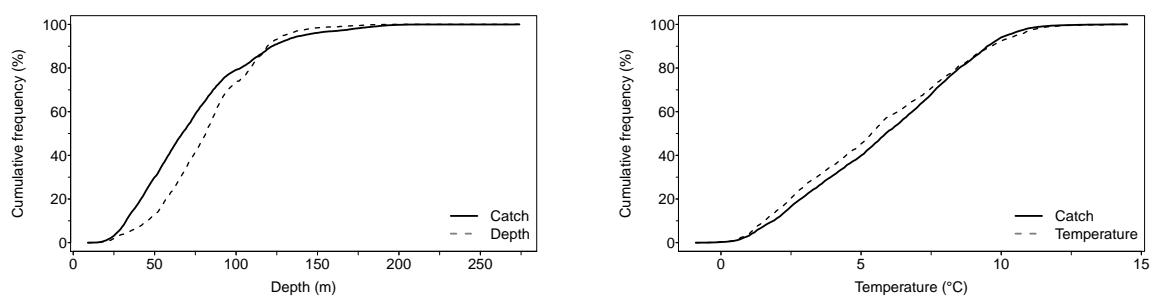
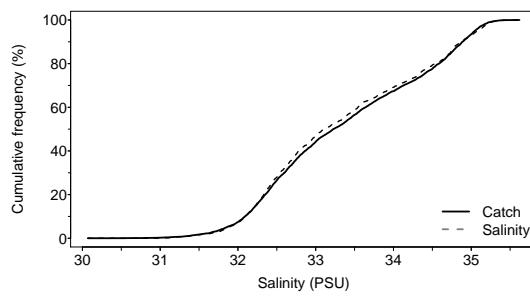


Figure 7.4D. Average fish condition in NAFO units 4X and 4VW for Red hake.



734



Freq	Depth	Temp	Sal
F5	35	1.1	31.00
F25	62	2.9	32.43
F50	82	5.4	33.12
F75	103	7.9	34.32
F95	130	10.0	35.08

Figure 7.4E. Catch distribution by depth, temperature and salinity of Red hake.

735

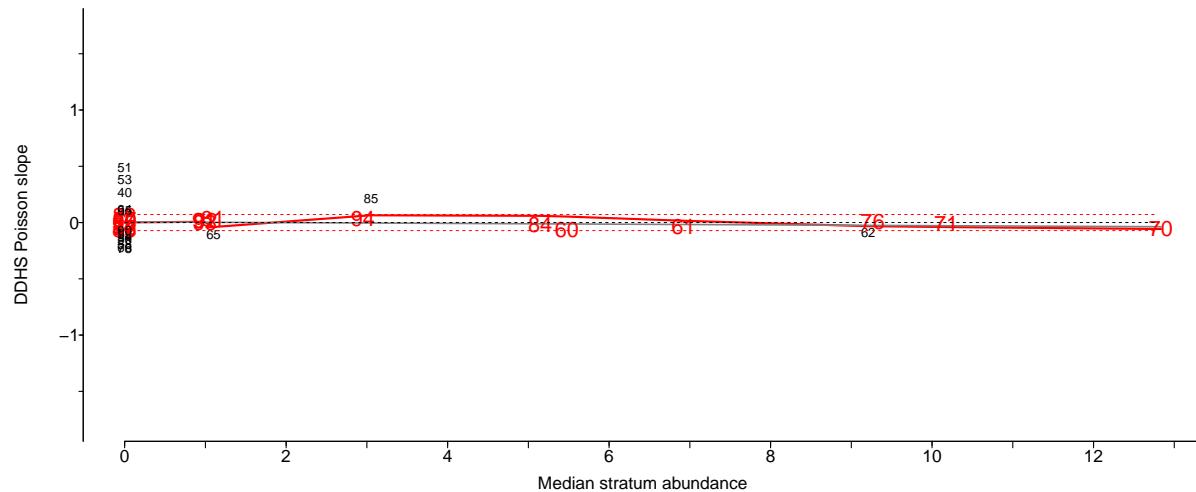


Figure 7.4F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Red hake.

736

7.5 Silver hake (*Merlu argenté*) - species code 14 (category LF)

737

Scientific name: [Merluccius bilinearis](#)

738

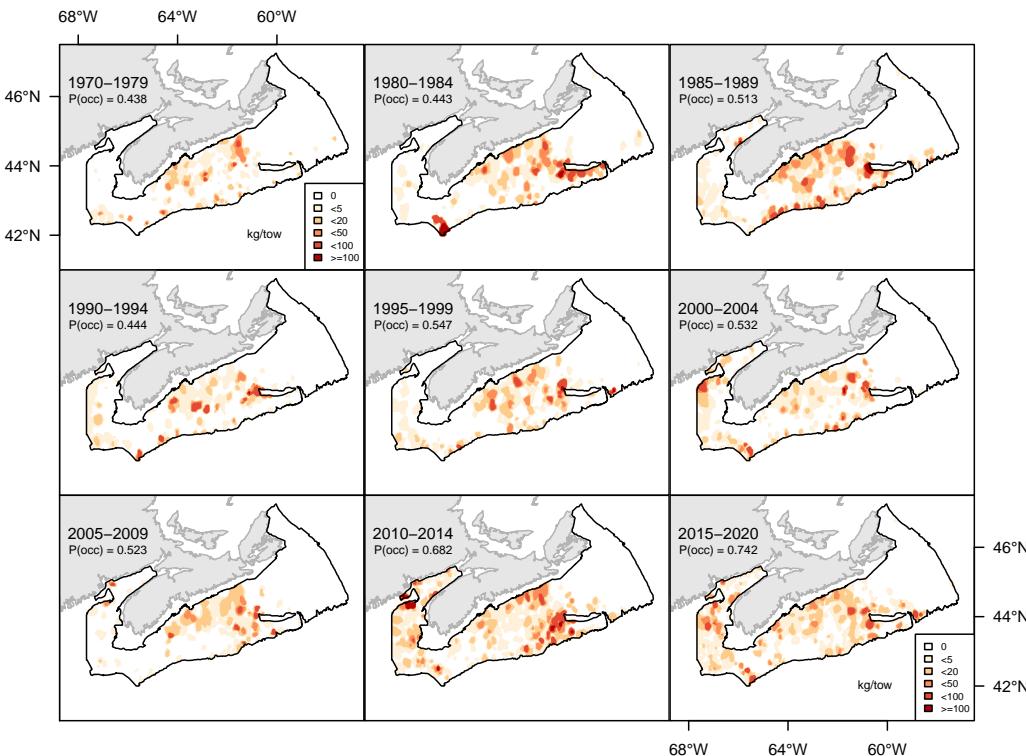


Figure 7.5A. Inverse distance weighted distribution of catch biomass (kg/tow) for Silver hake.

739

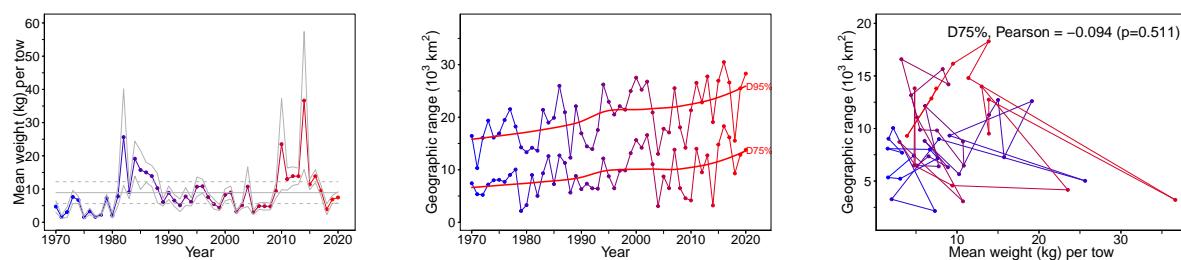


Figure 7.5B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Silver hake.

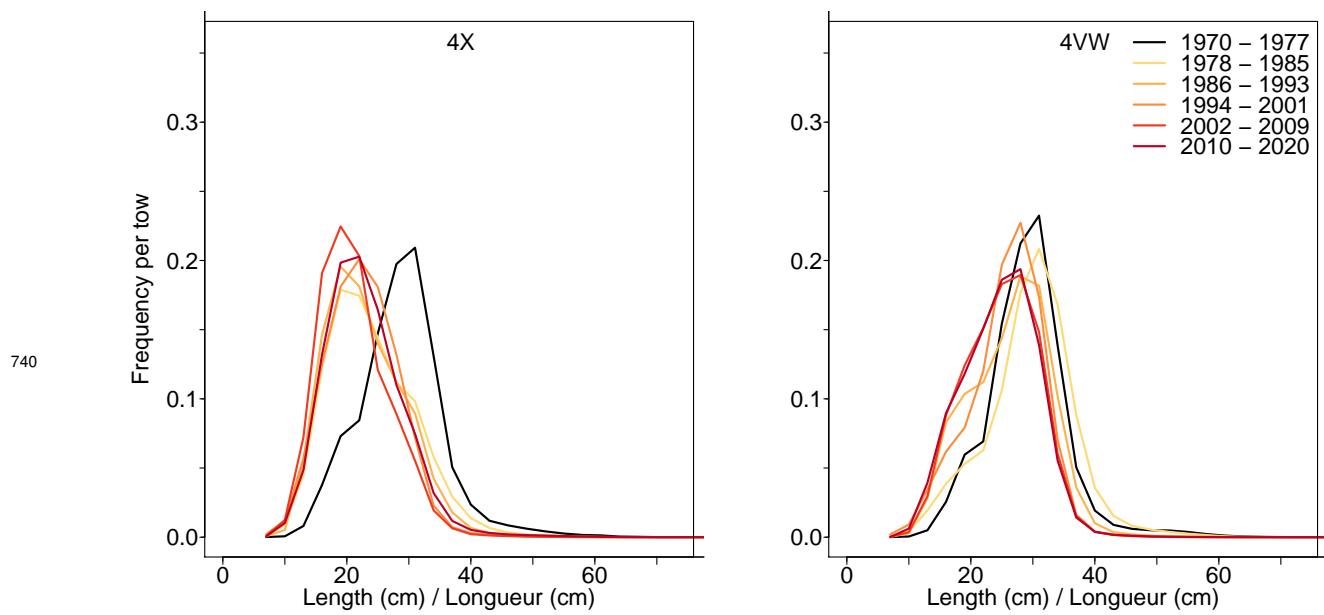


Figure 7.5C. Length frequency distribution in NAFO units 4X and 4VW for Silver hake.

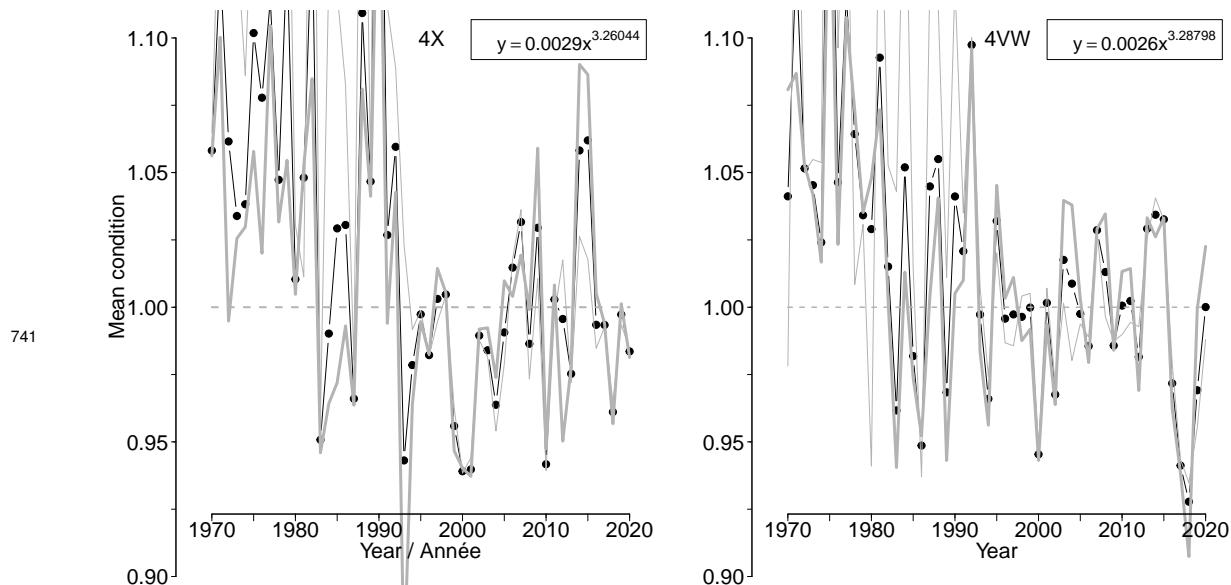
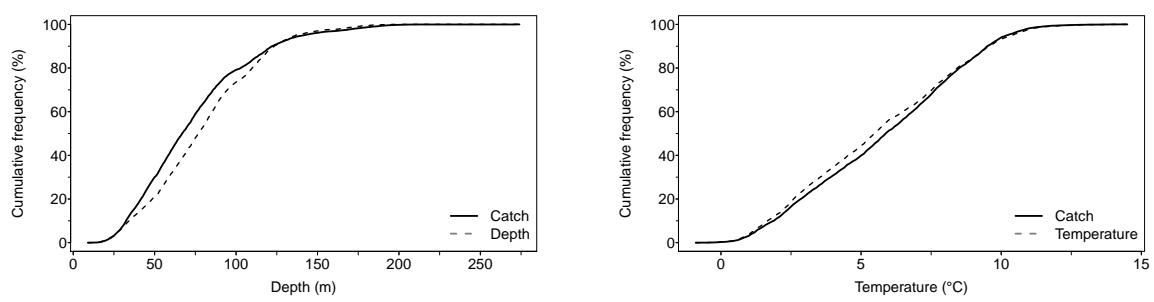
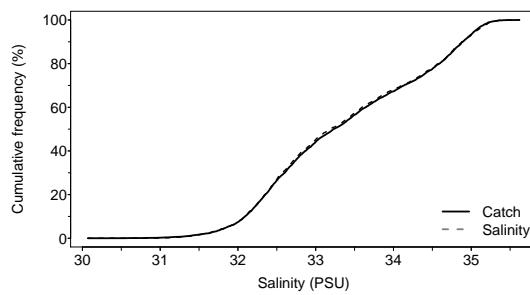


Figure 7.5D. Average fish condition in NAFO units 4X and 4VW for Silver hake.



742



Freq	Depth	Temp	Sal
F5	28	1.2	31.00
F25	55	3.1	32.46
F50	77	5.5	33.20
F75	104	8.0	34.37
F95	137	10.0	35.07

Figure 7.5E. Catch distribution by depth, temperature and salinity of Silver hake.

743

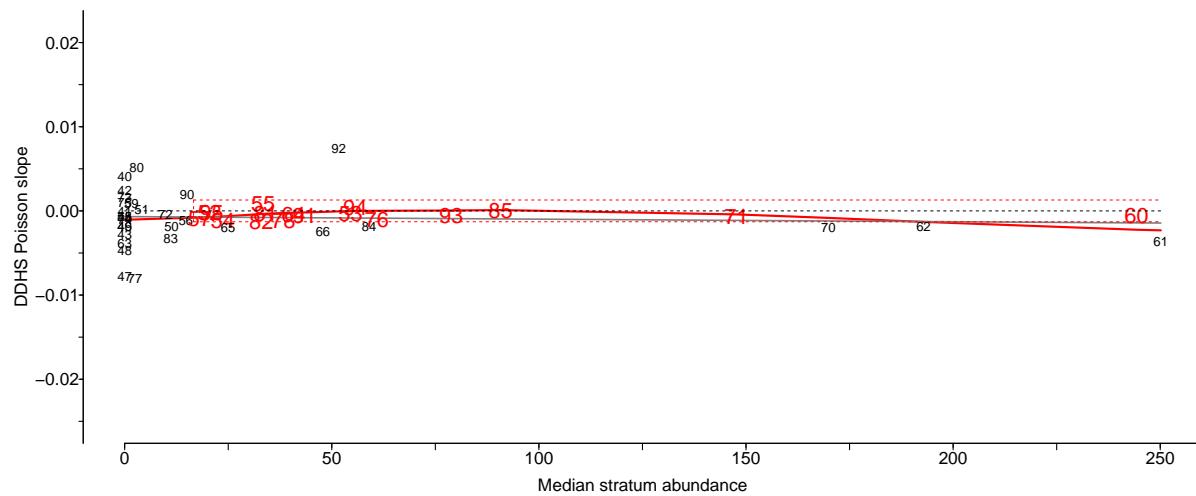


Figure 7.5F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Silver hake.

744

7.6 Pollock (Goberge) - species code 16 (category LF)

745

Scientific name: [Pollachius virens](#)

746

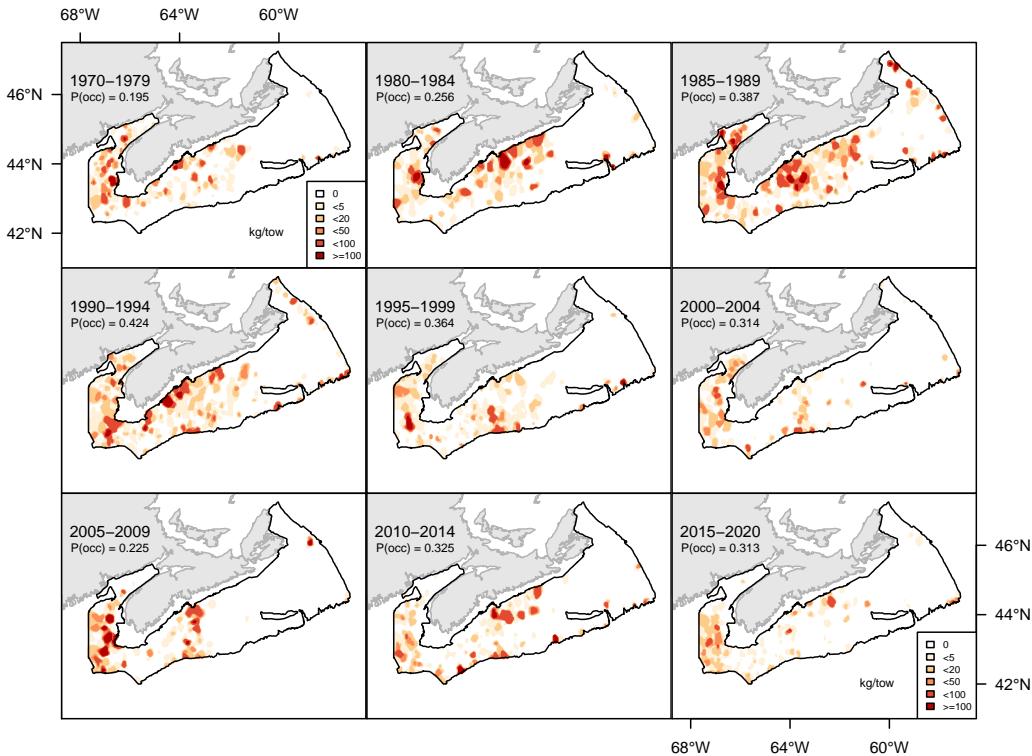


Figure 7.6A. Inverse distance weighted distribution of catch biomass (kg/tow) for Pollock.

747

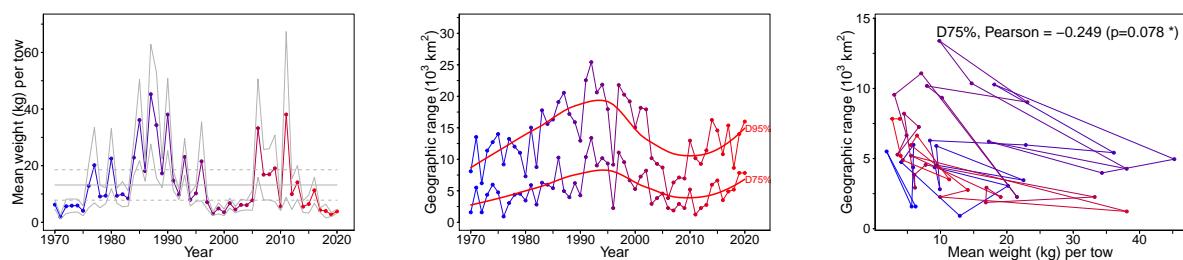


Figure 7.6B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Pollock.

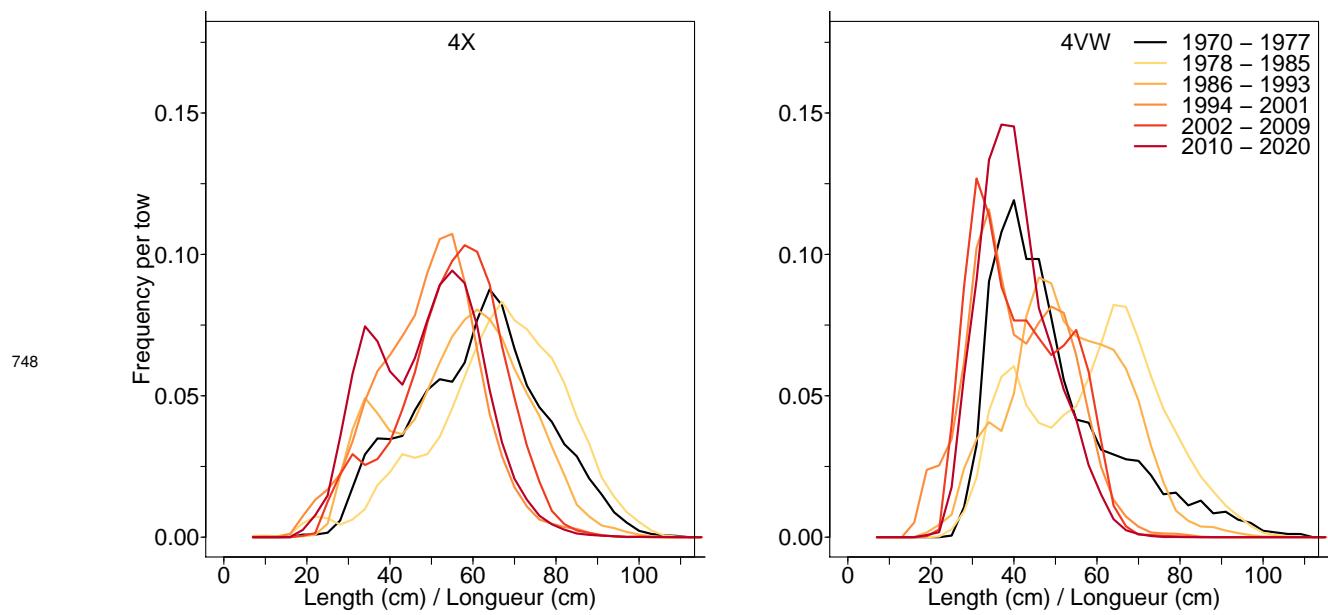


Figure 7.6C. Length frequency distribution in NAFO units 4X and 4VW for Pollock.

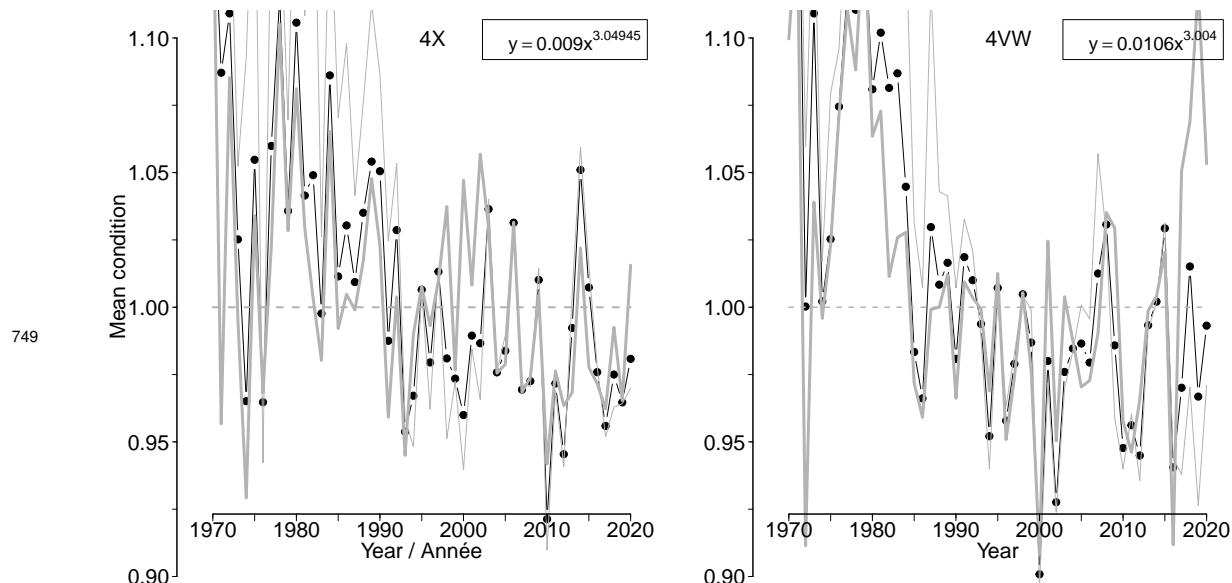


Figure 7.6D. Average fish condition in NAFO units 4X and 4VW for Pollock.

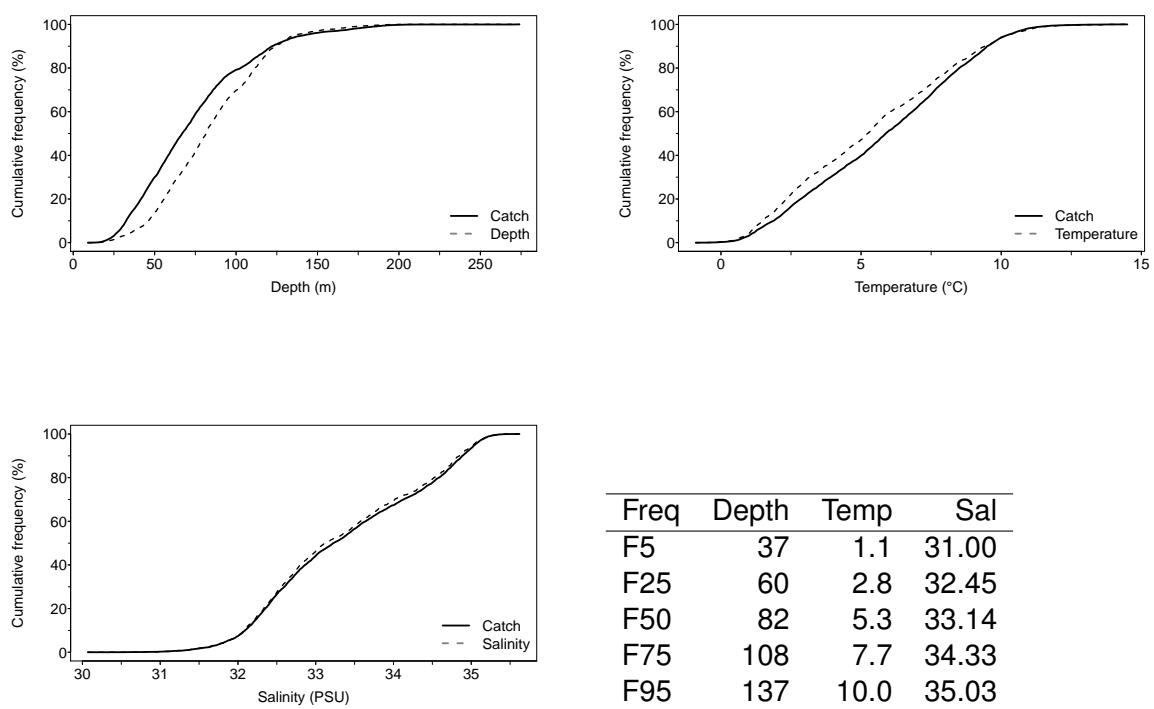


Figure 7.6E. Catch distribution by depth, temperature and salinity of Pollock.

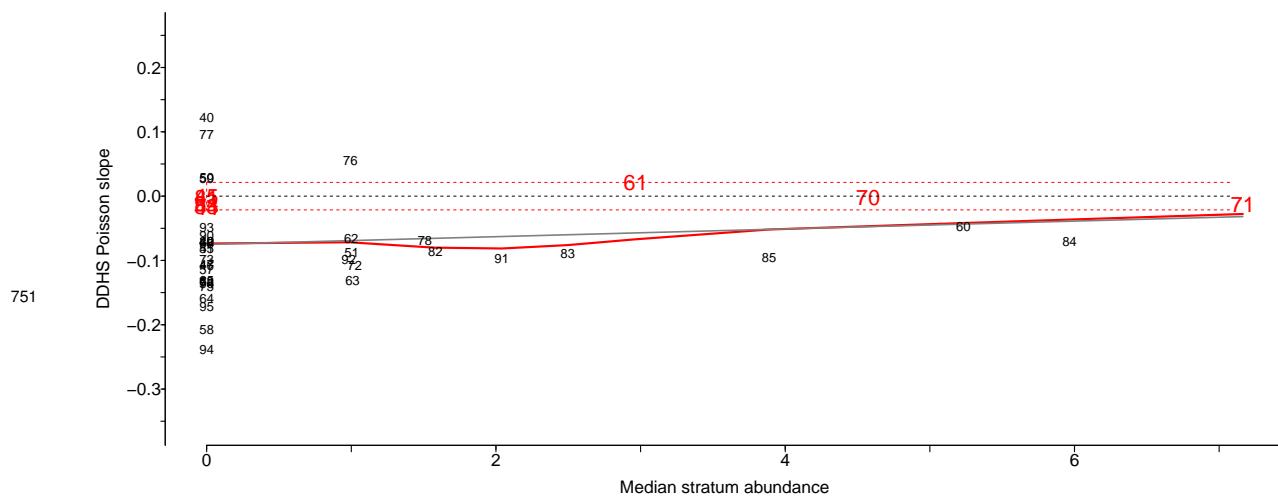


Figure 7.6F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Pollock.

752

7.7 Atlantic redfishes (Sébastes de l'Atlantique) - species code 23 (category LF)

753

Scientific name: [Sebastes](#)

754

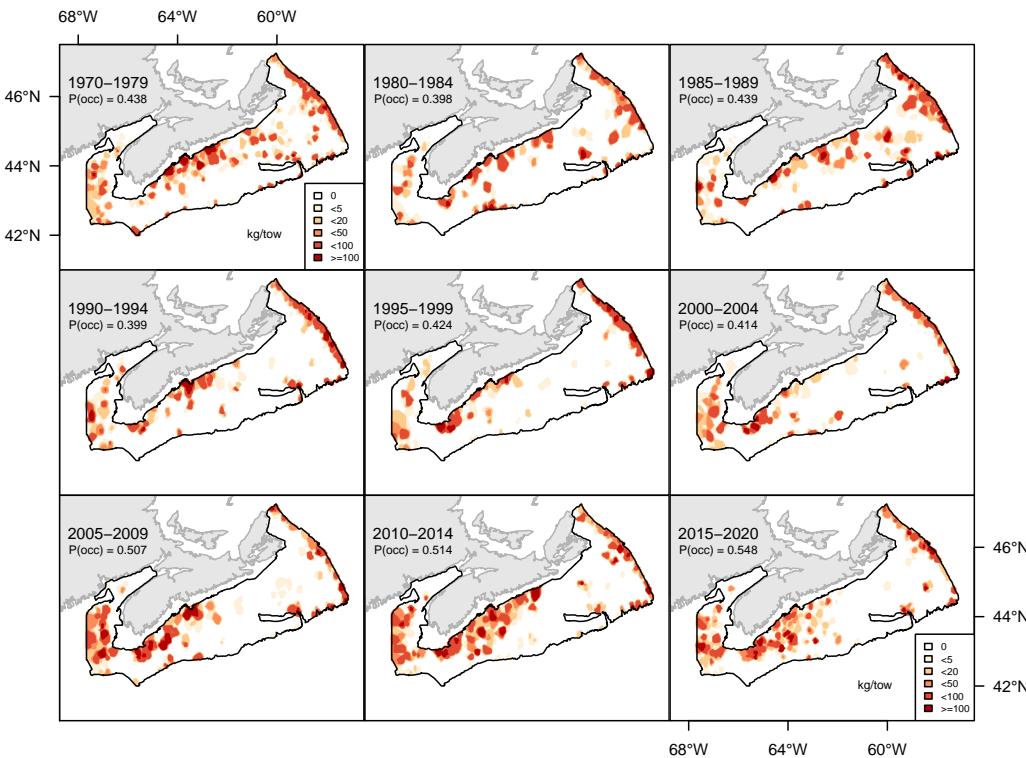


Figure 7.7A. Inverse distance weighted distribution of catch biomass (kg/tow) for Atlantic redfishes.

755

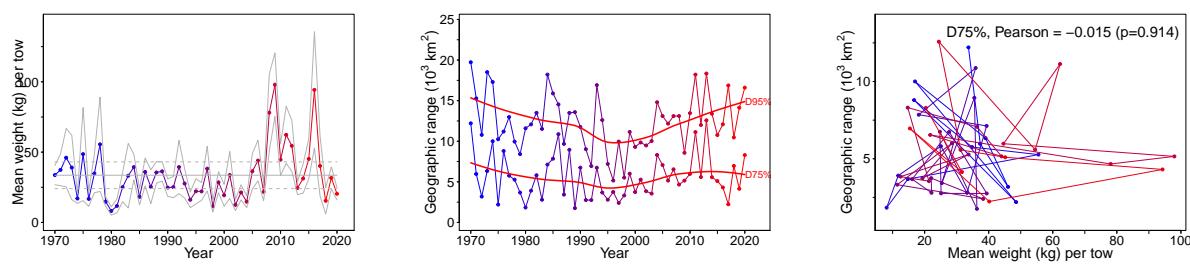


Figure 7.7B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Atlantic redfishes.

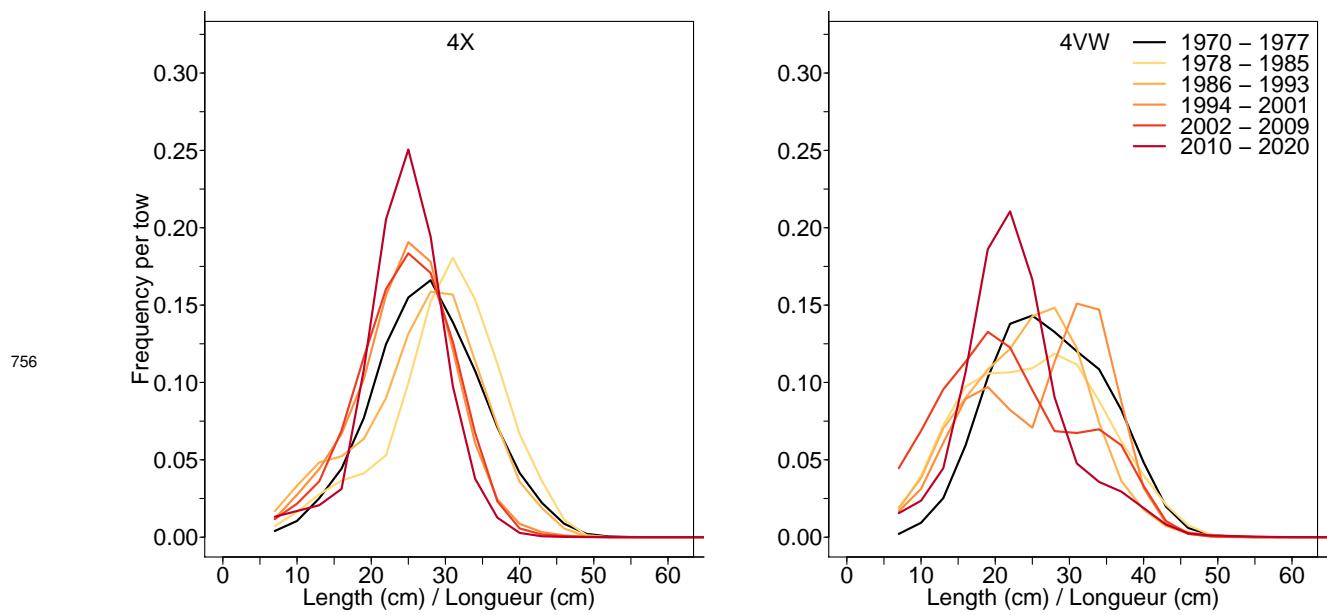


Figure 7.7C. Length frequency distribution in NAFO units 4X and 4VW for Atlantic redfishes.

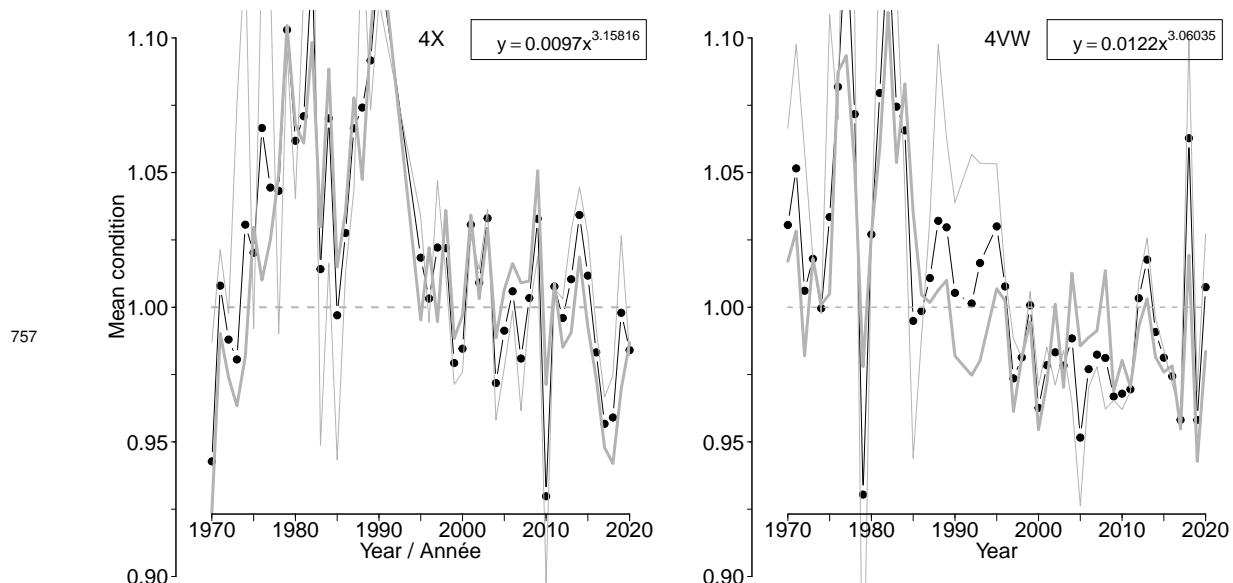
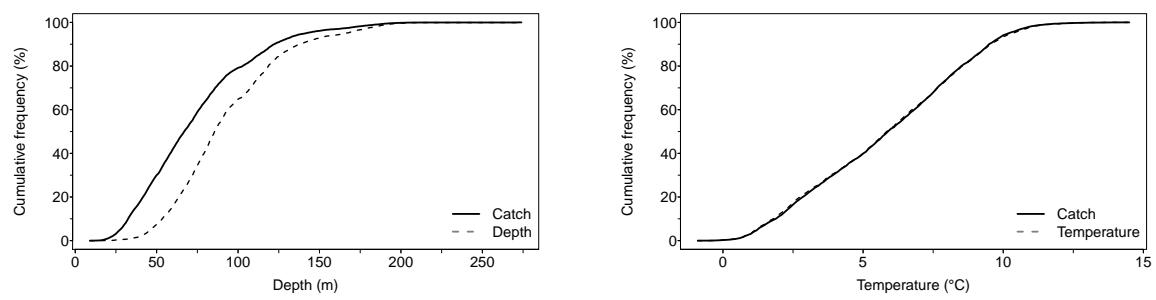
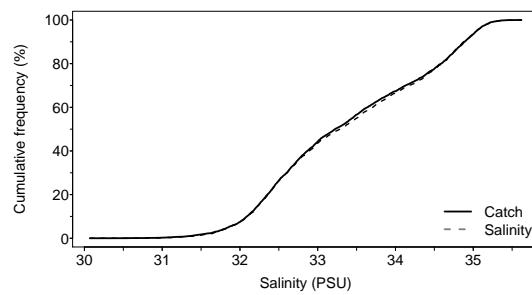


Figure 7.7D. Average fish condition in NAFO units 4X and 4VW for Atlantic redfishes.



758



Freq	Depth	Temp	Sal
F5	47	1.2	31.00
F25	68	3.4	32.48
F50	86	5.9	33.29
F75	114	8.1	34.41
F95	166	10.0	35.05

Figure 7.7E. Catch distribution by depth, temperature and salinity of Atlantic redfishes.

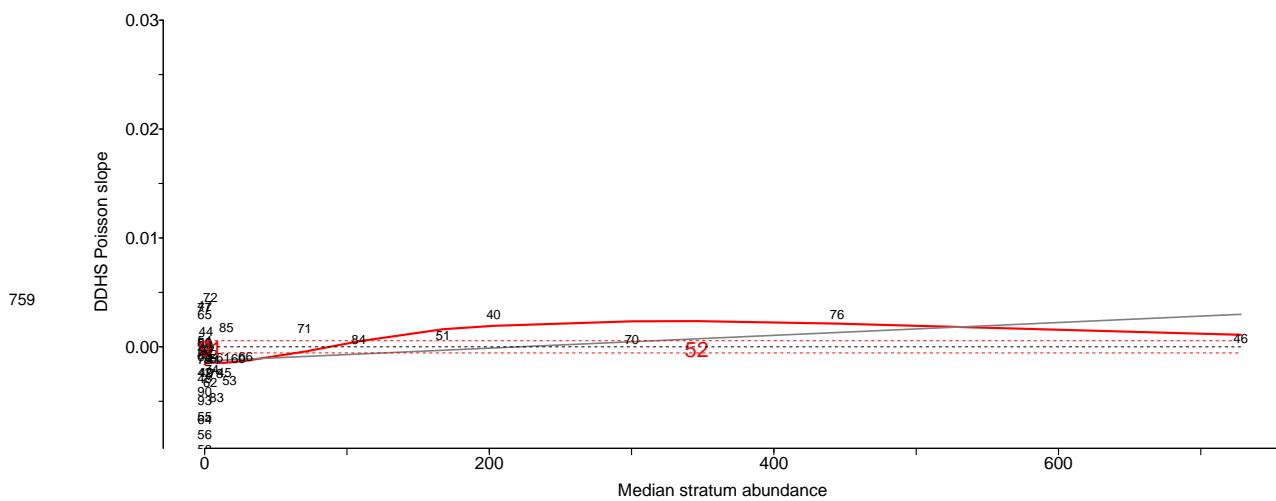


Figure 7.7F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Atlantic redfishes.

760

7.8 Atlantic halibut (Flétan de l'Atlantique) - species code 30 (category LF)

761

Scientific name: [Hippoglossus hippoglossus](#)

762

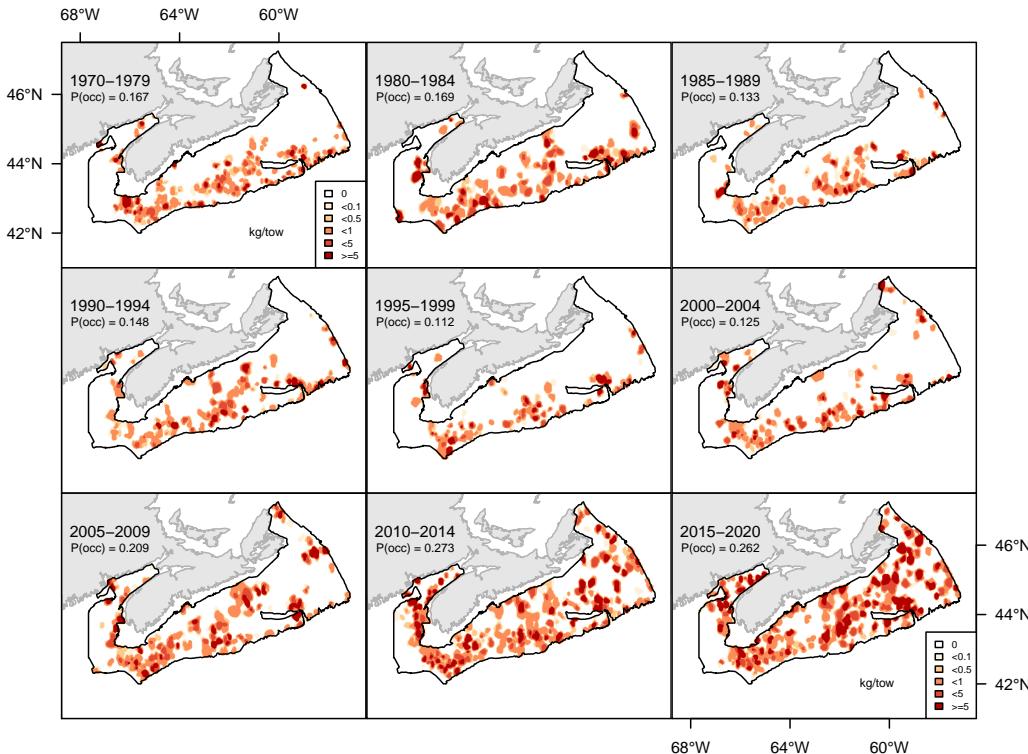


Figure 7.8A. Inverse distance weighted distribution of catch biomass (kg/tow) for Atlantic halibut.

763

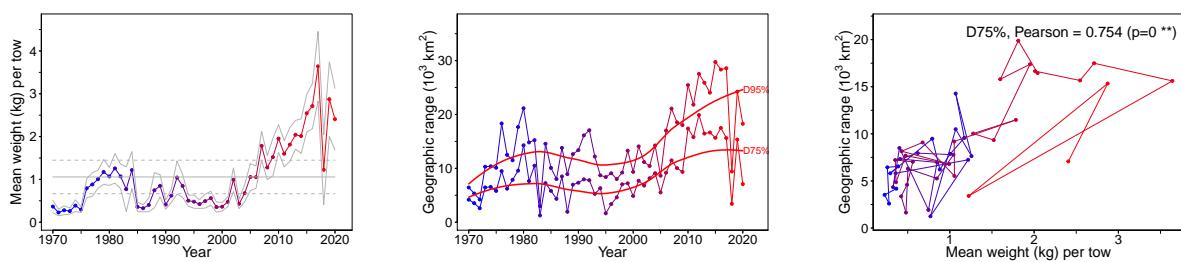


Figure 7.8B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Atlantic halibut.

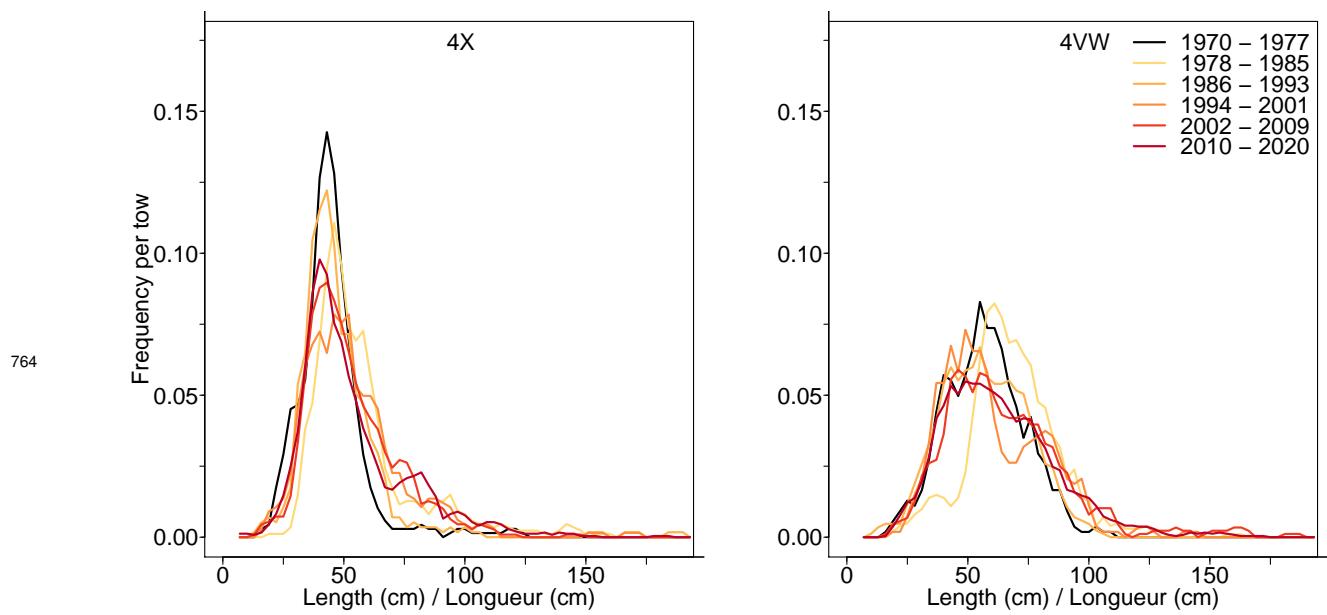


Figure 7.8C. Length frequency distribution in NAFO units 4X and 4VW for Atlantic halibut.

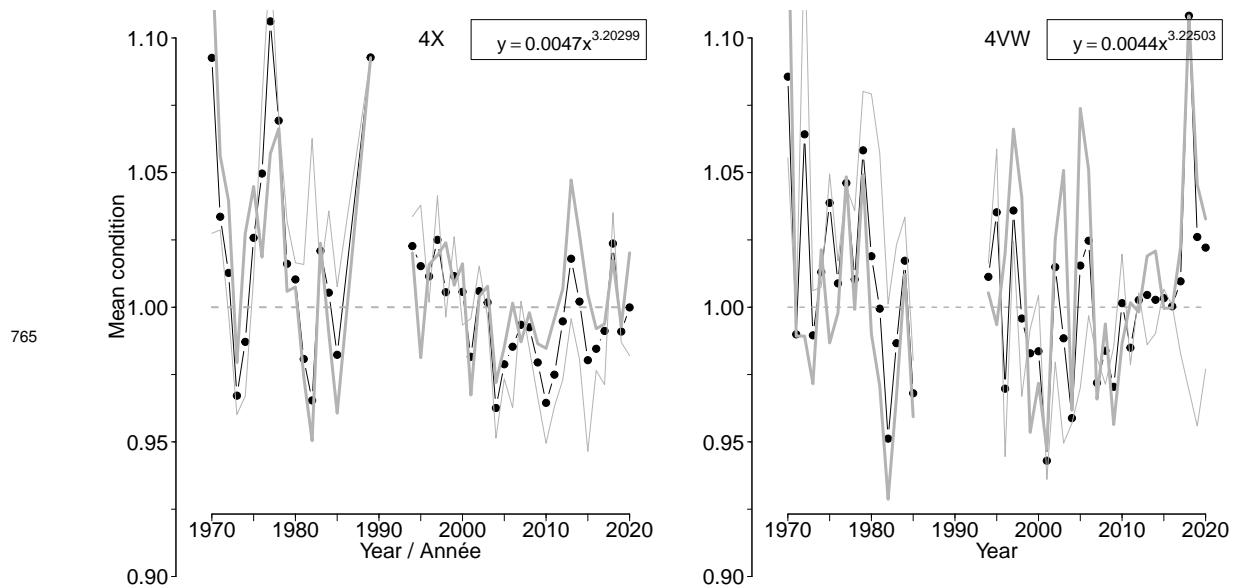
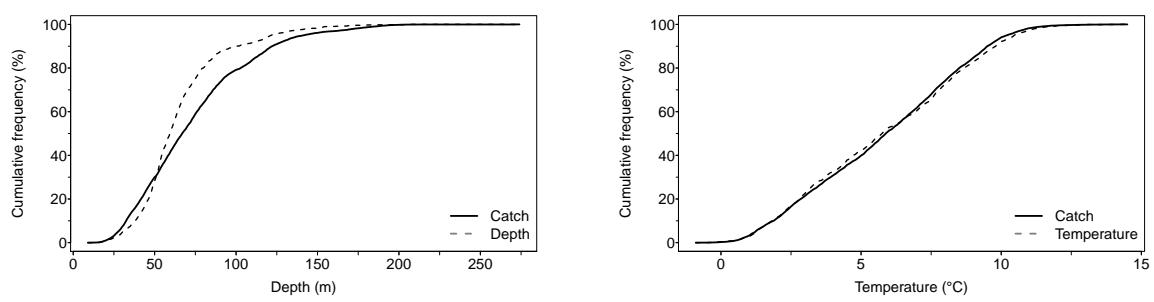
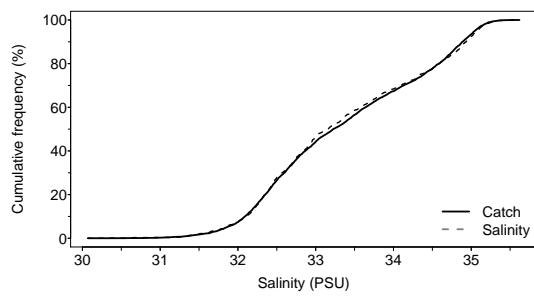


Figure 7.8D. Average fish condition in NAFO units 4X and 4VW for Atlantic halibut.



766



Freq	Depth	Temp	Sal
F5	31	1.3	31.00
F25	49	3.2	32.45
F50	60	5.8	33.16
F75	75	8.3	34.34
F95	122	10.0	35.08

Figure 7.8E. Catch distribution by depth, temperature and salinity of Atlantic halibut.

767

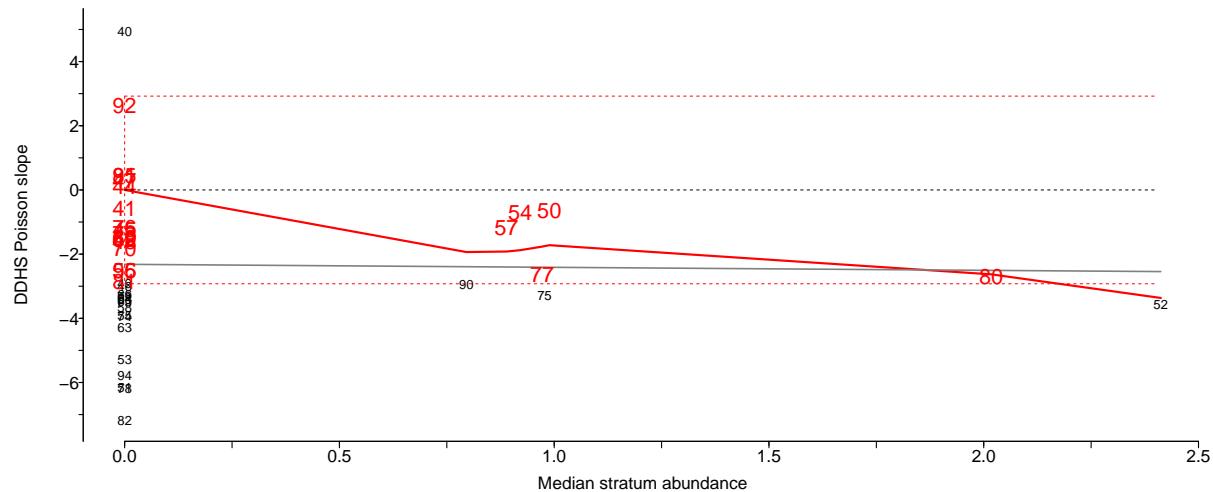


Figure 7.8F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Atlantic halibut.

768

7.9 American plaice (*Ple canadienne*) - species code 40 (category LF)

769

Scientific name: [Hippoglossoides platessoides](#)

770

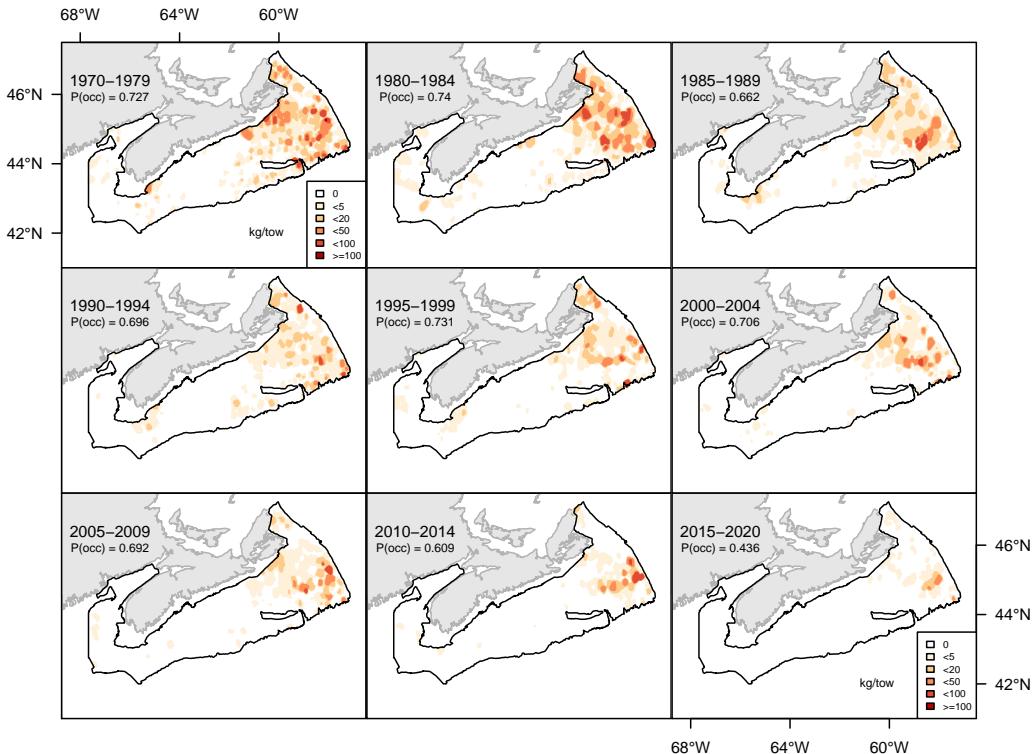


Figure 7.9A. Inverse distance weighted distribution of catch biomass (kg/tow) for American plaice.

771

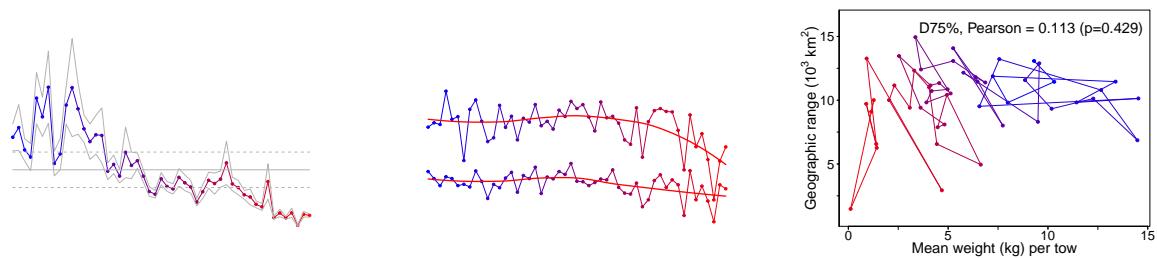


Figure 7.9B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of American plaice.

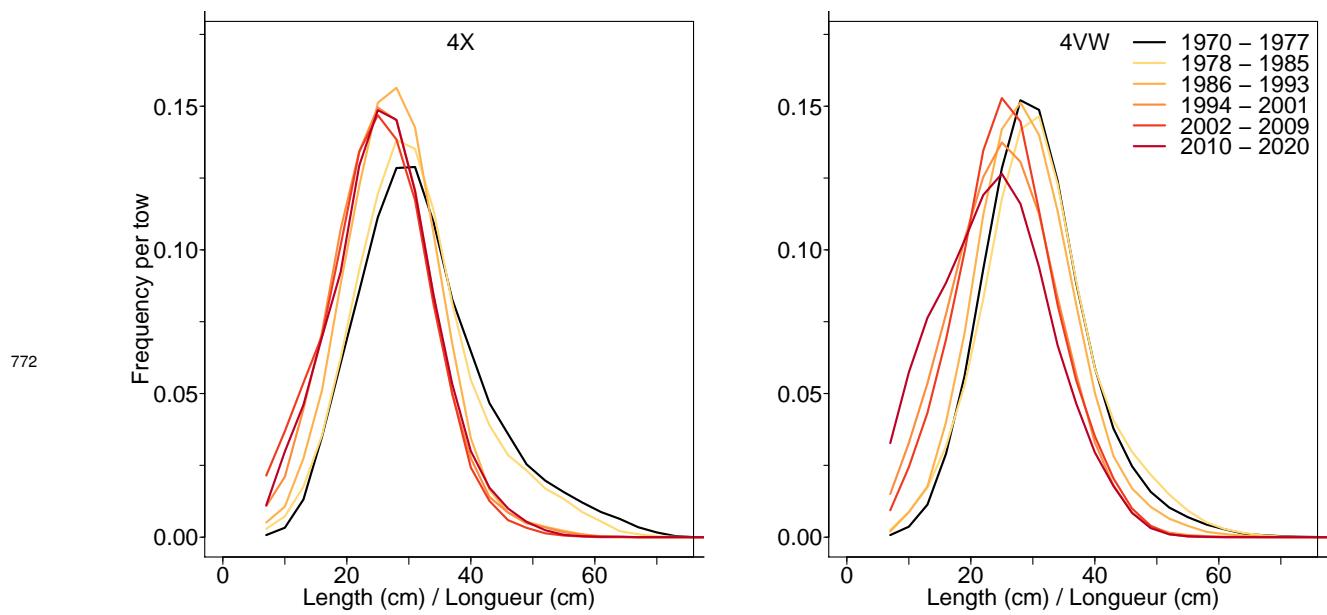


Figure 7.9C. Length frequency distribution in NAFO units 4X and 4VW for American plaice.

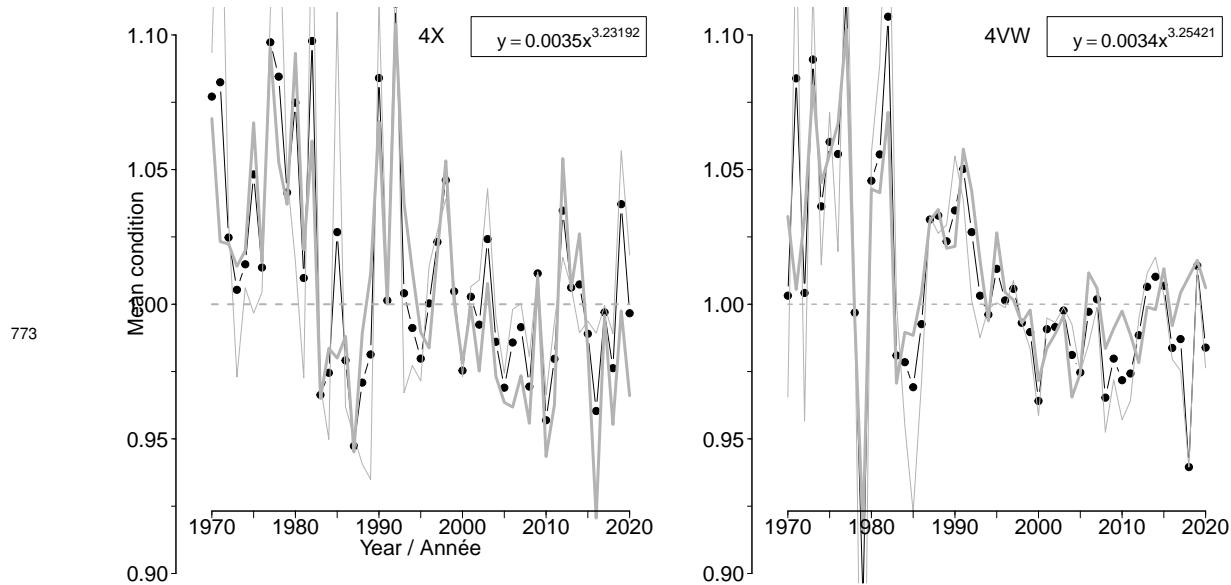
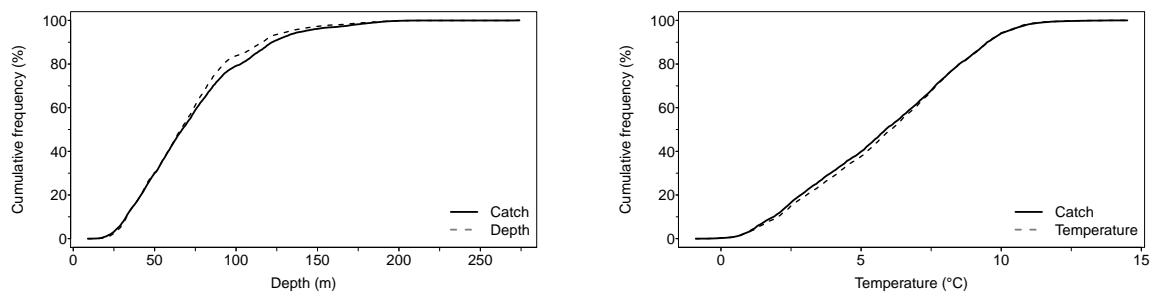
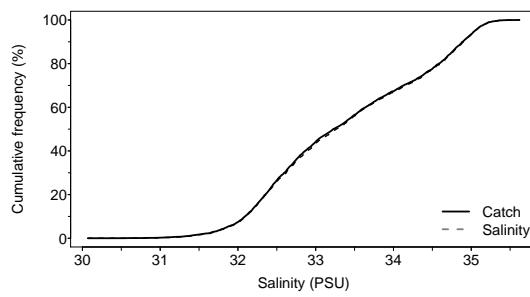


Figure 7.9D. Average fish condition in NAFO units 4X and 4VW for American plaice.



774



Freq	Depth	Temp	Sal
F5	29	1.3	31.00
F25	46	3.7	32.48
F50	67	6.1	33.27
F75	87	8.1	34.41
F95	133	10.0	35.05

Figure 7.9E. Catch distribution by depth, temperature and salinity of American plaice.

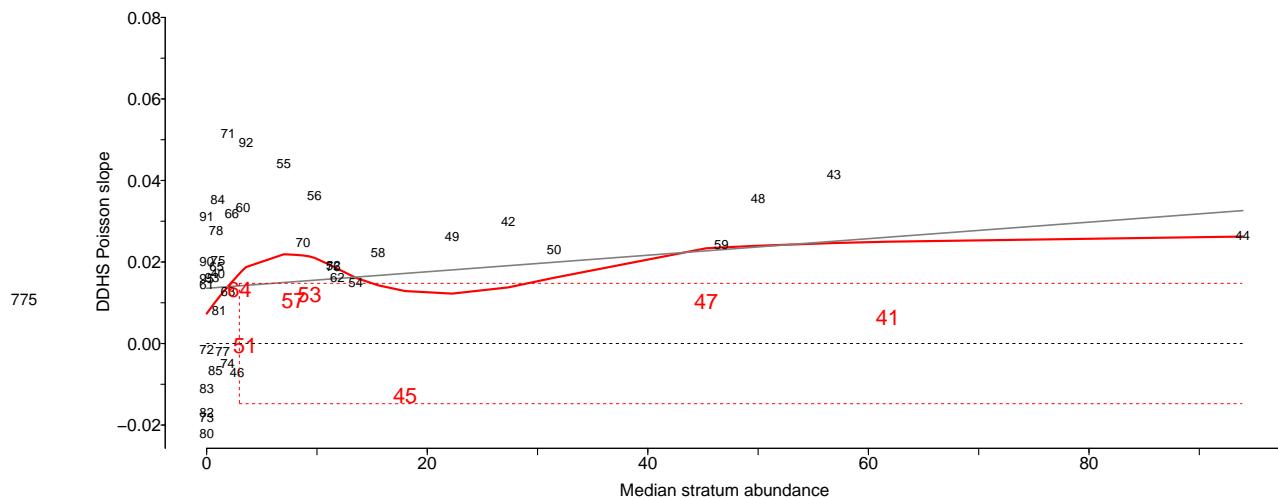


Figure 7.9F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for American plaice.

776

7.10 Witch flounder (*Ple grise*) - species code 41 (category LF)

777

Scientific name: [Glyptocephalus cynoglossus](#)

778

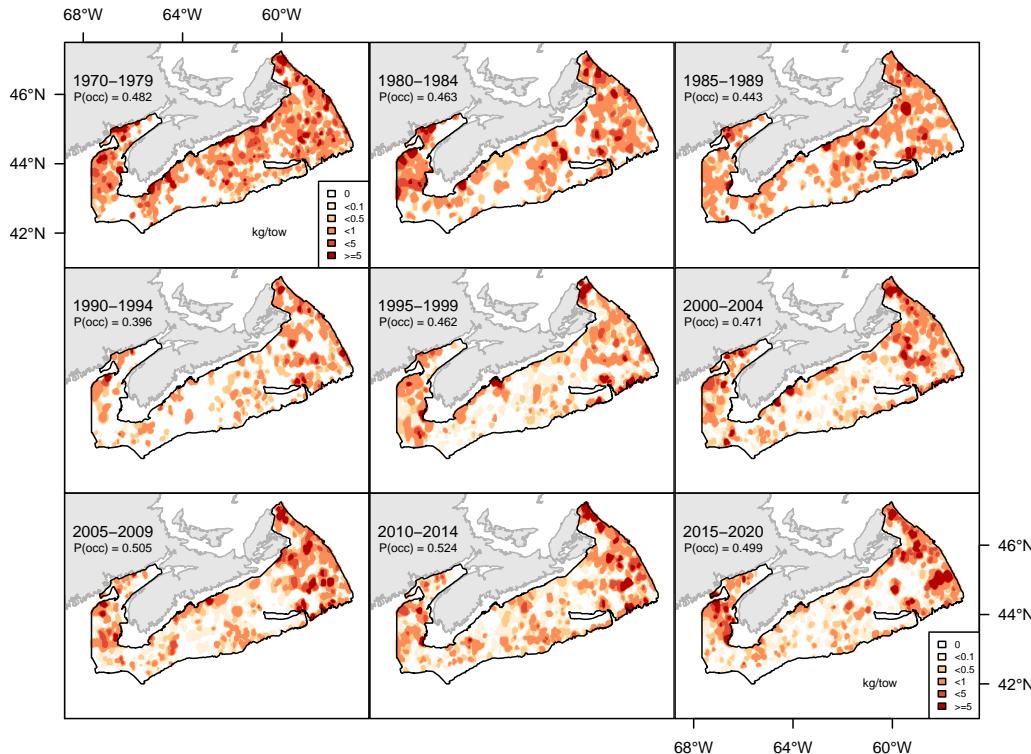


Figure 7.10A. Inverse distance weighted distribution of catch biomass (kg/tow) for Witch flounder.

779

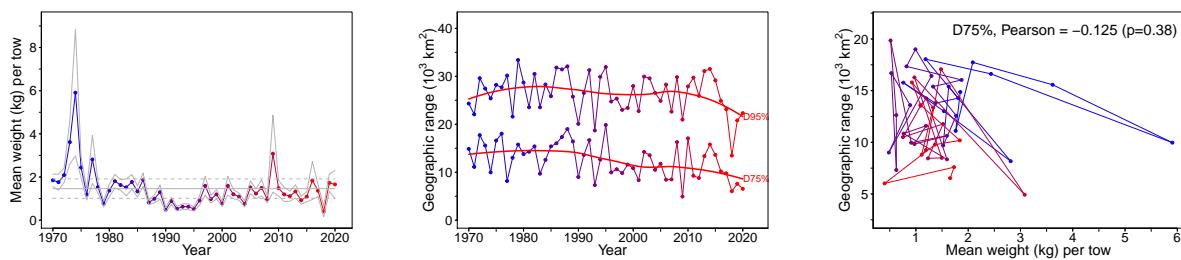


Figure 7.10B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Witch flounder.

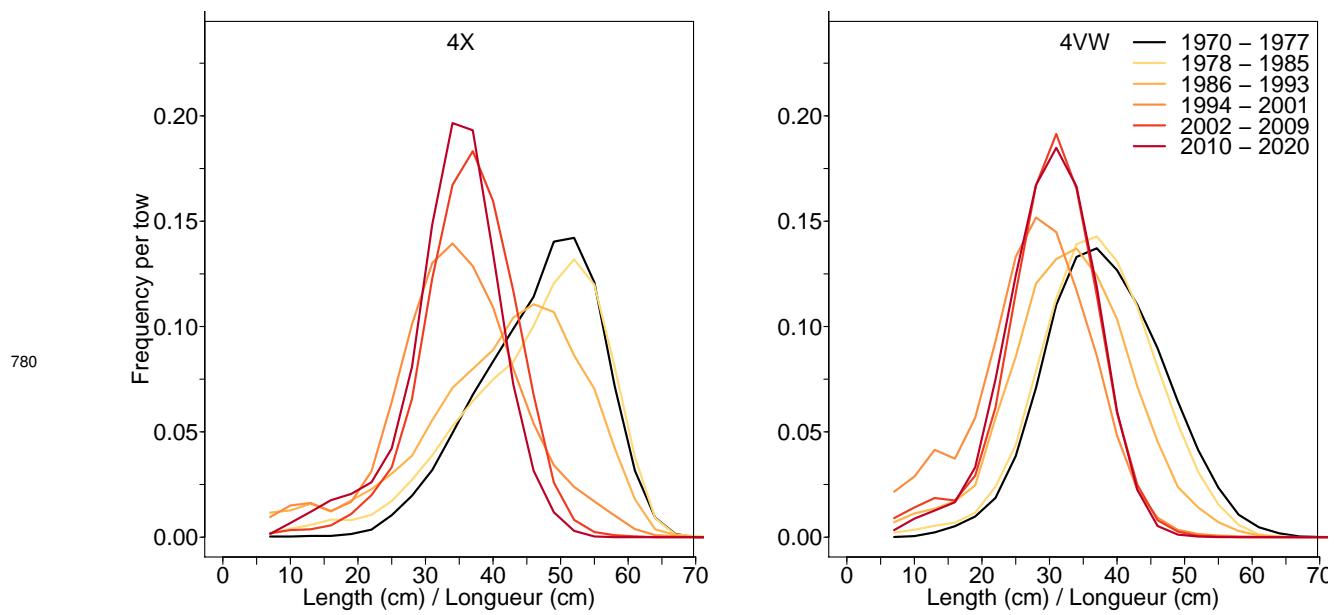


Figure 7.10C. Length frequency distribution in NAFO units 4X and 4VW for Witch flounder.

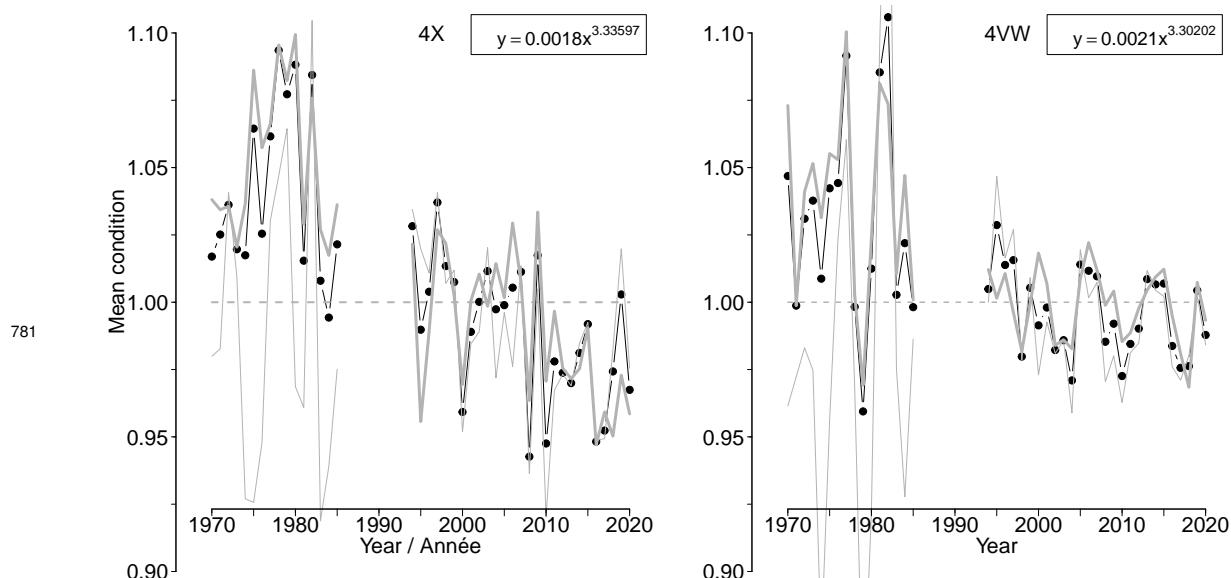
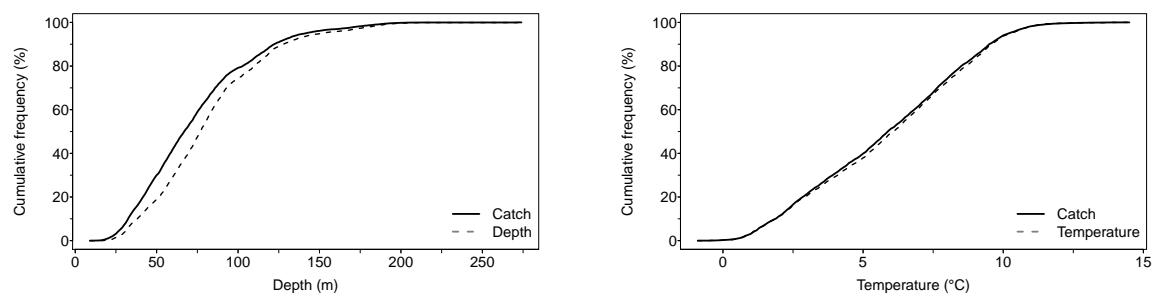
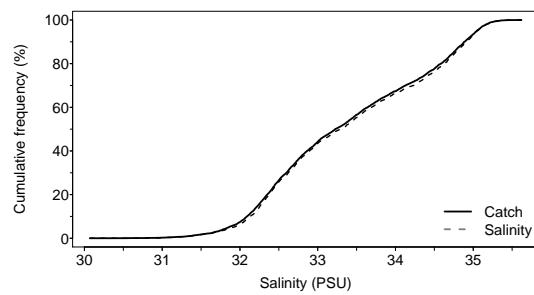


Figure 7.10D. Average fish condition in NAFO units 4X and 4VW for Witch flounder.



782



Freq	Depth	Temp	Sal
F5	32	1.3	31.00
F25	57	3.5	32.49
F50	77	6.1	33.30
F75	102	8.2	34.45
F95	152	10.0	35.06

Figure 7.10E. Catch distribution by depth, temperature and salinity of Witch flounder.

783

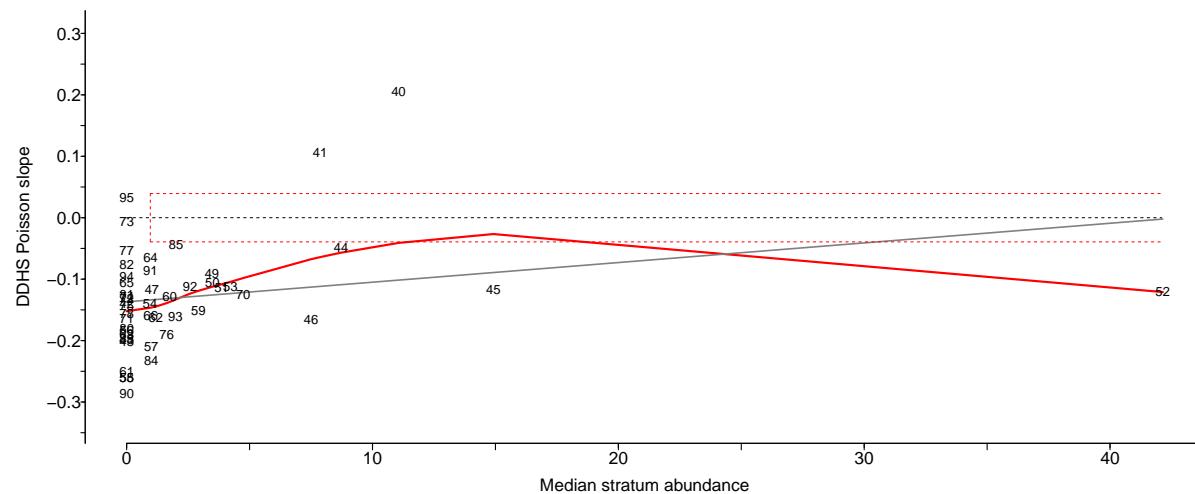


Figure 7.10F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Witch flounder.

784

7.11 Yellowtail flounder (Limande à queue jaune) - species code 42 (category LF)

785

Scientific name: [Limanda ferruginea](#)

786

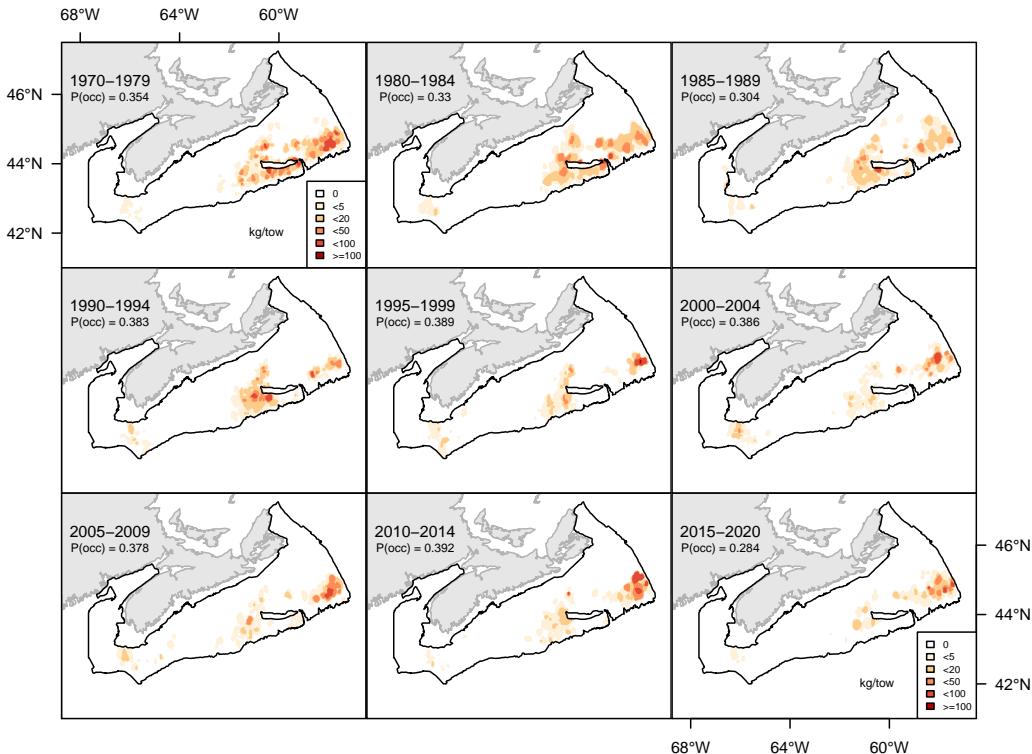


Figure 7.11A. Inverse distance weighted distribution of catch biomass (kg/tow) for Yellowtail flounder.

787

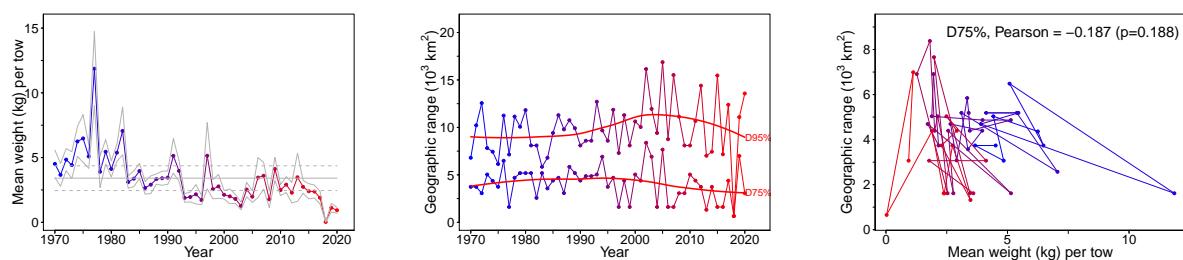


Figure 7.11B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Yellowtail flounder.

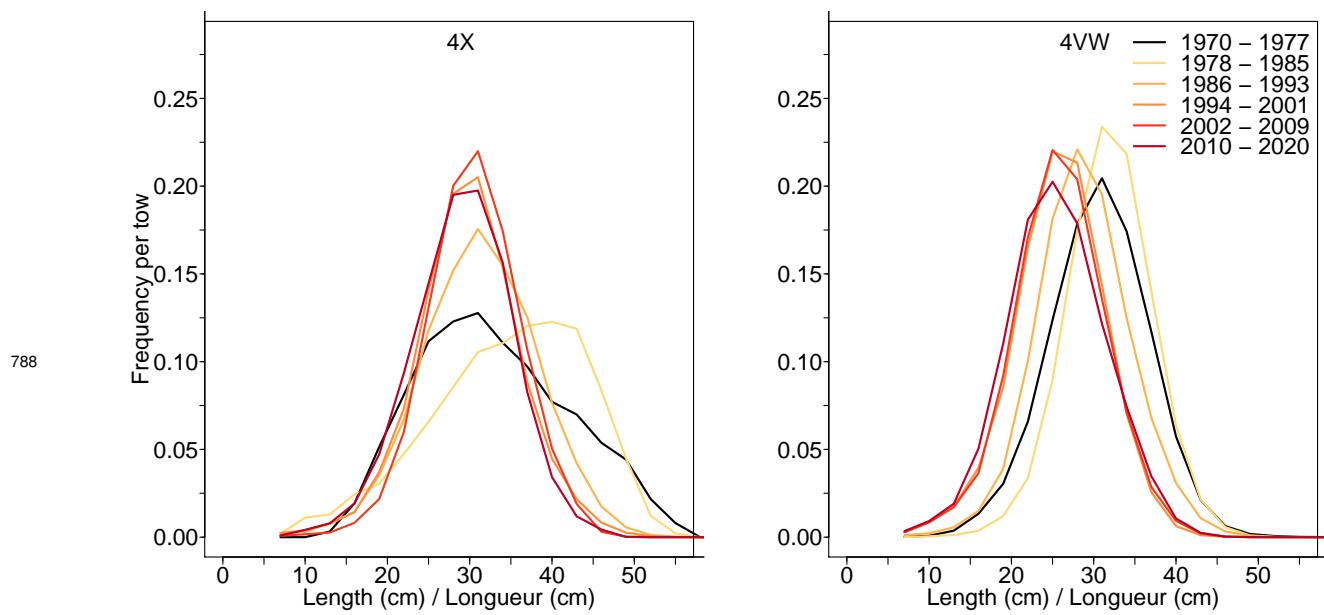


Figure 7.11C. Length frequency distribution in NAFO units 4X and 4VW for Yellowtail flounder.

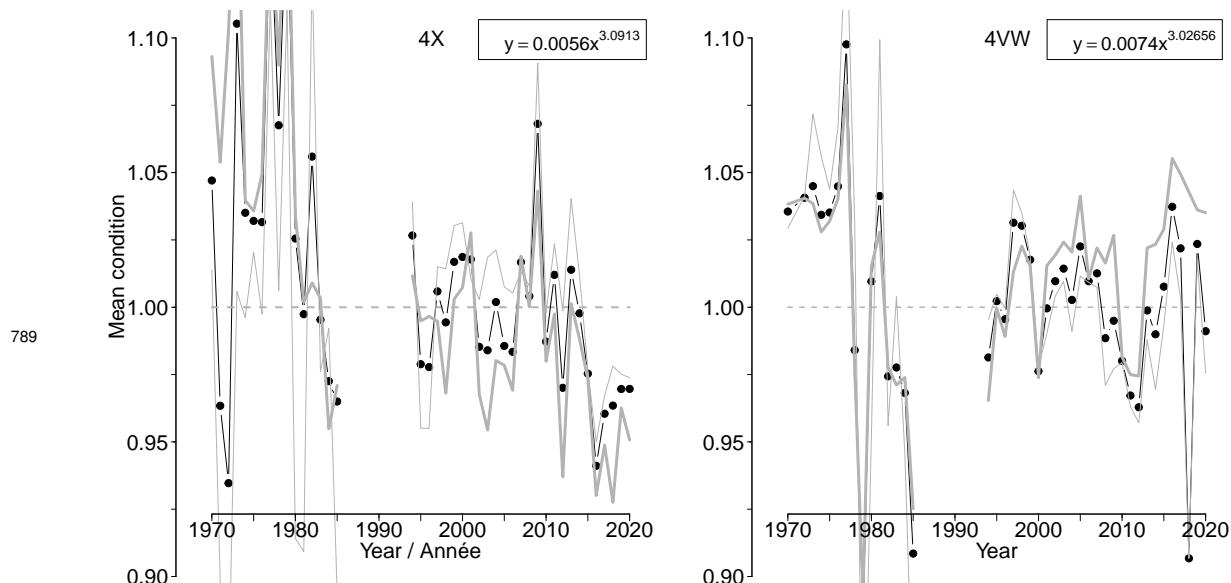
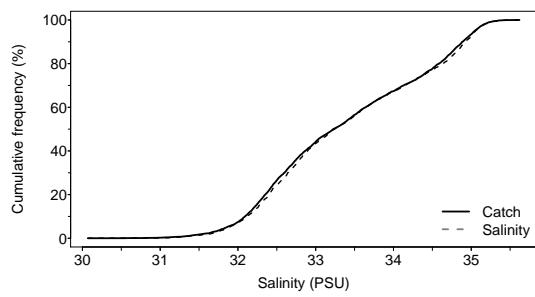
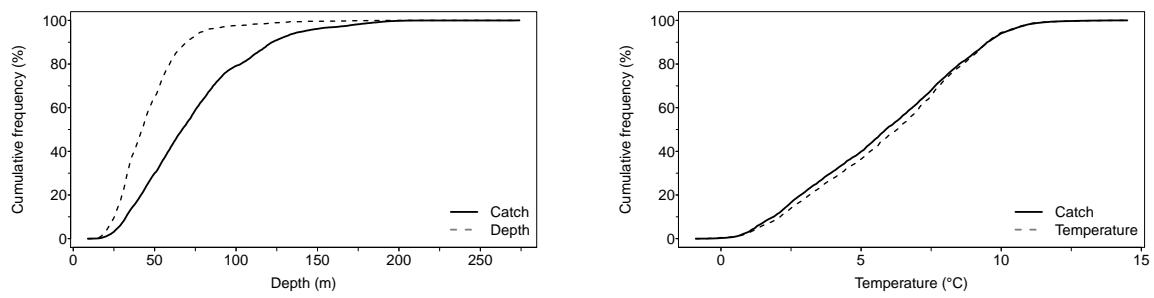


Figure 7.11D. Average fish condition in NAFO units 4X and 4VW for Yellowtail flounder.



Freq	Depth	Temp	Sal
F5	22	1.4	31.00
F25	32	3.7	32.52
F50	43	6.3	33.25
F75	56	8.2	34.41
F95	81	10.0	35.06

Figure 7.11E. Catch distribution by depth, temperature and salinity of Yellowtail flounder.

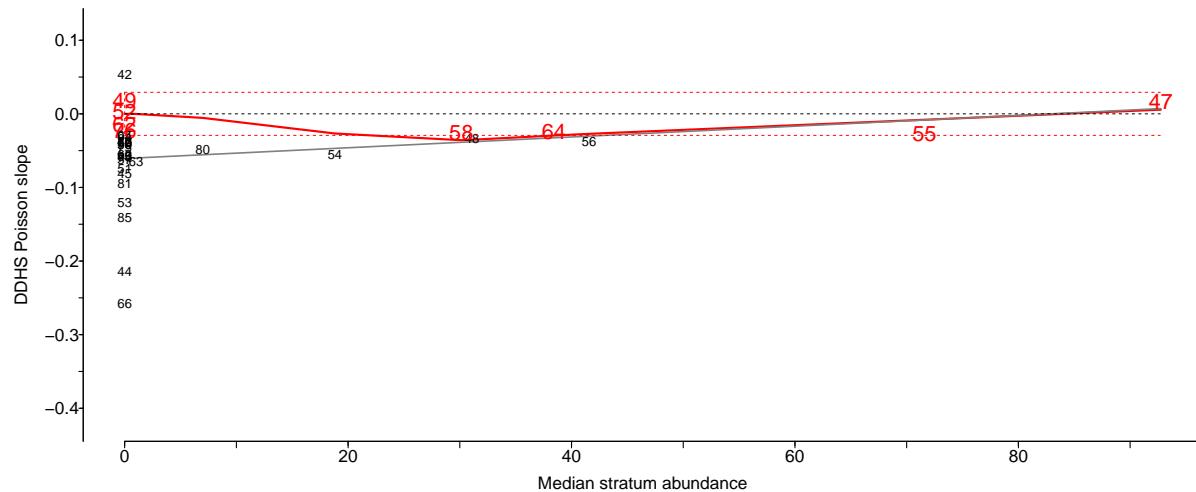


Figure 7.11F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Yellowtail flounder.

792

7.12 Winter flounder (Limande-plie rouge) - species code 43 (category LF)

793

Scientific name: [Pseudopleuronectes americanus](#)

794

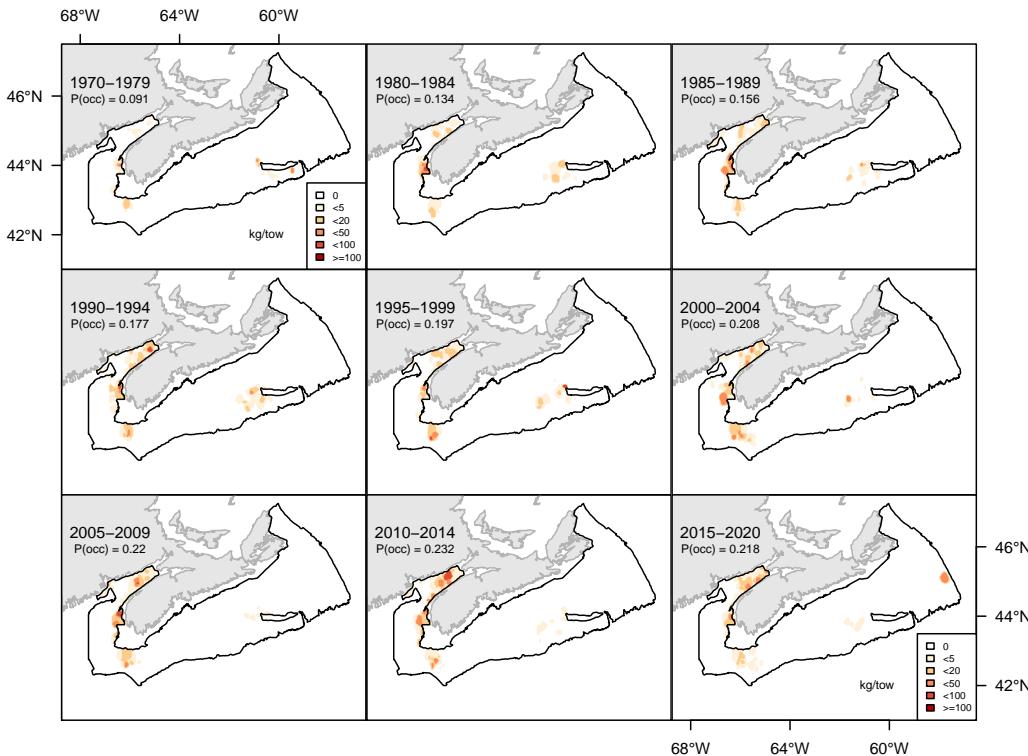


Figure 7.12A. Inverse distance weighted distribution of catch biomass (kg/tow) for Winter flounder.

795

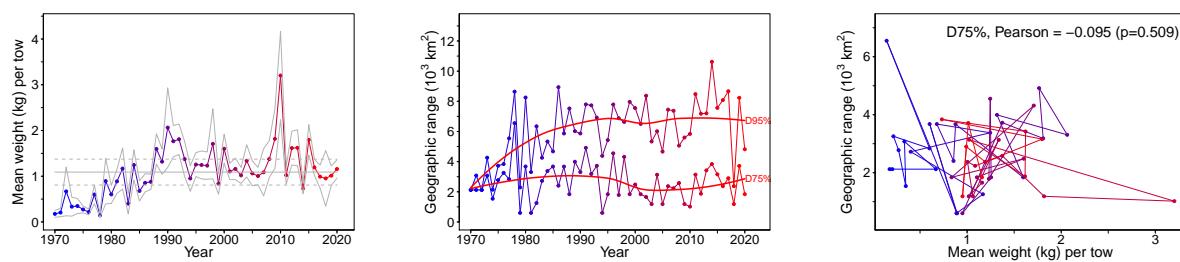


Figure 7.12B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Winter flounder.

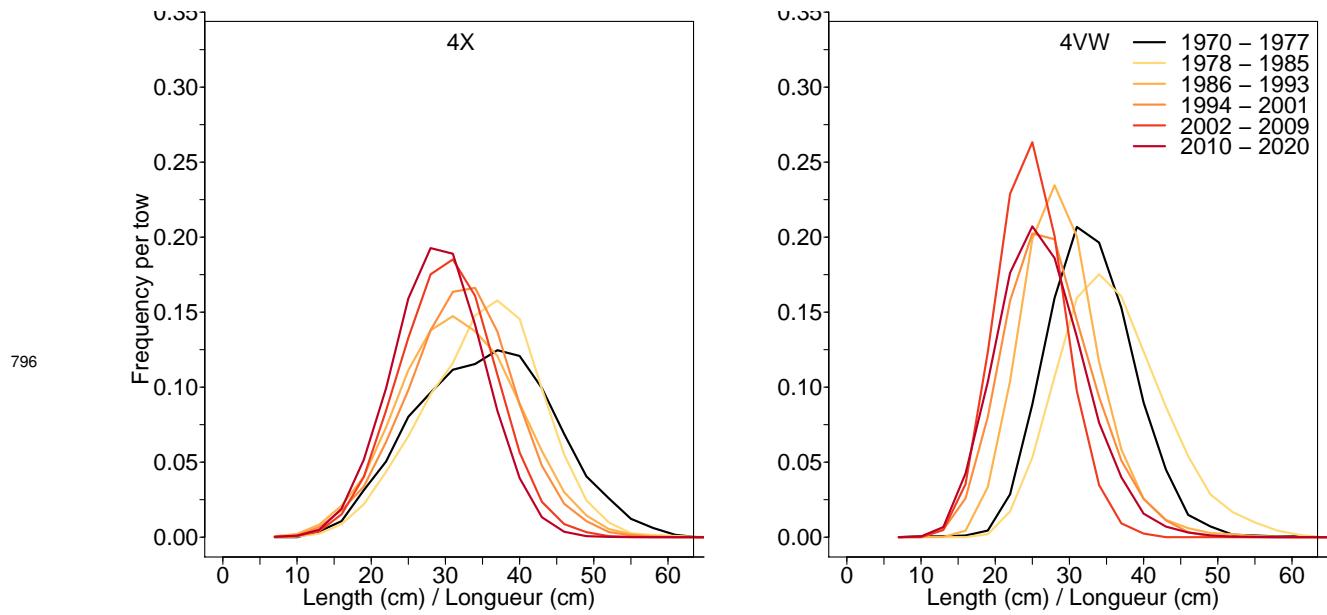


Figure 7.12C. Length frequency distribution in NAFO units 4X and 4VW for Winter flounder.

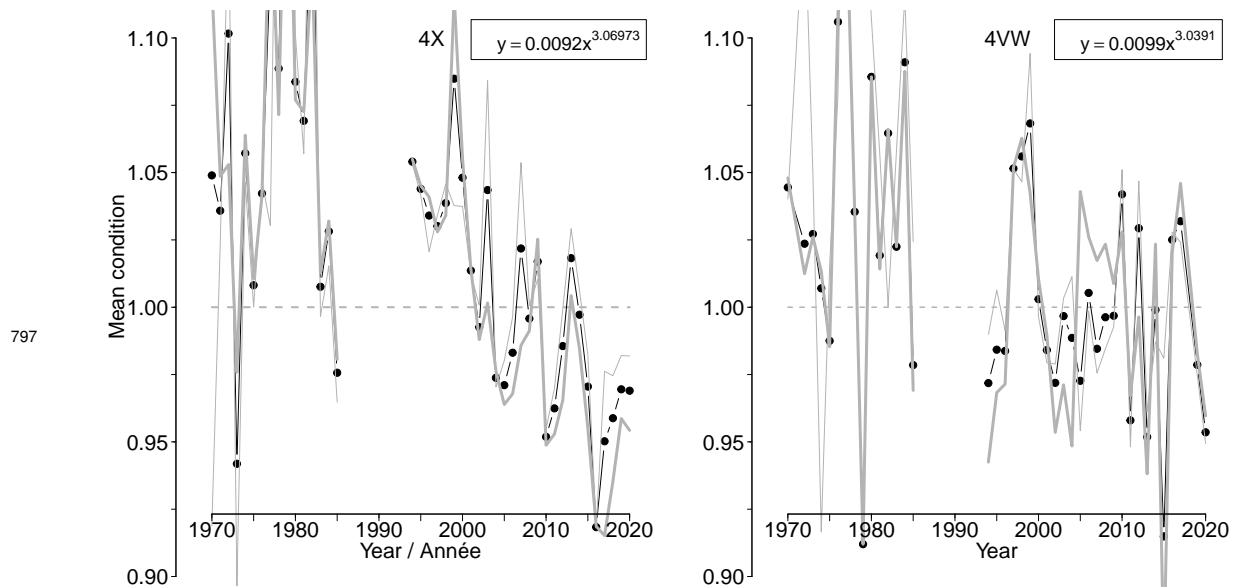
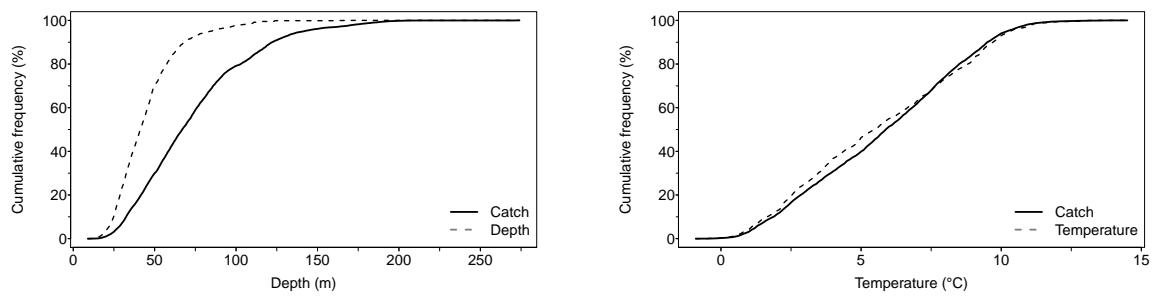
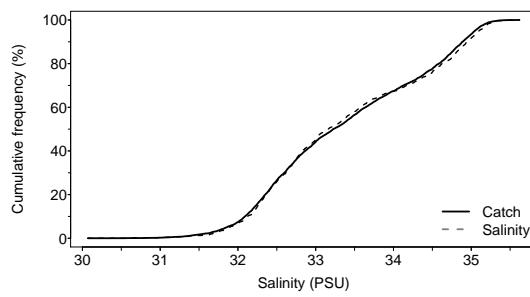


Figure 7.12D. Average fish condition in NAFO units 4X and 4VW for Winter flounder.



798



Freq	Depth	Temp	Sal
F5	22	1.1	31.00
F25	31	3.0	32.48
F50	42	5.5	33.17
F75	54	8.3	34.47
F95	84	10.0	35.10

Figure 7.12E. Catch distribution by depth, temperature and salinity of Winter flounder.

799

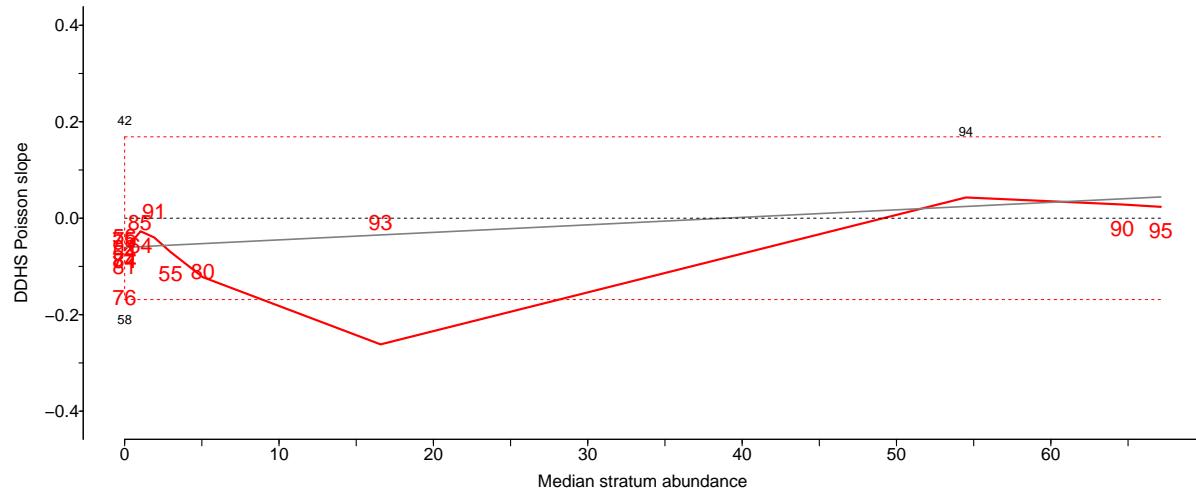


Figure 7.12F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Winter flounder.

800 **7.13 Atlantic wolffish (*Loup atlantique*) - species code 50 (category LF)**

801 Scientific name: [Anarhichas lupus](#)

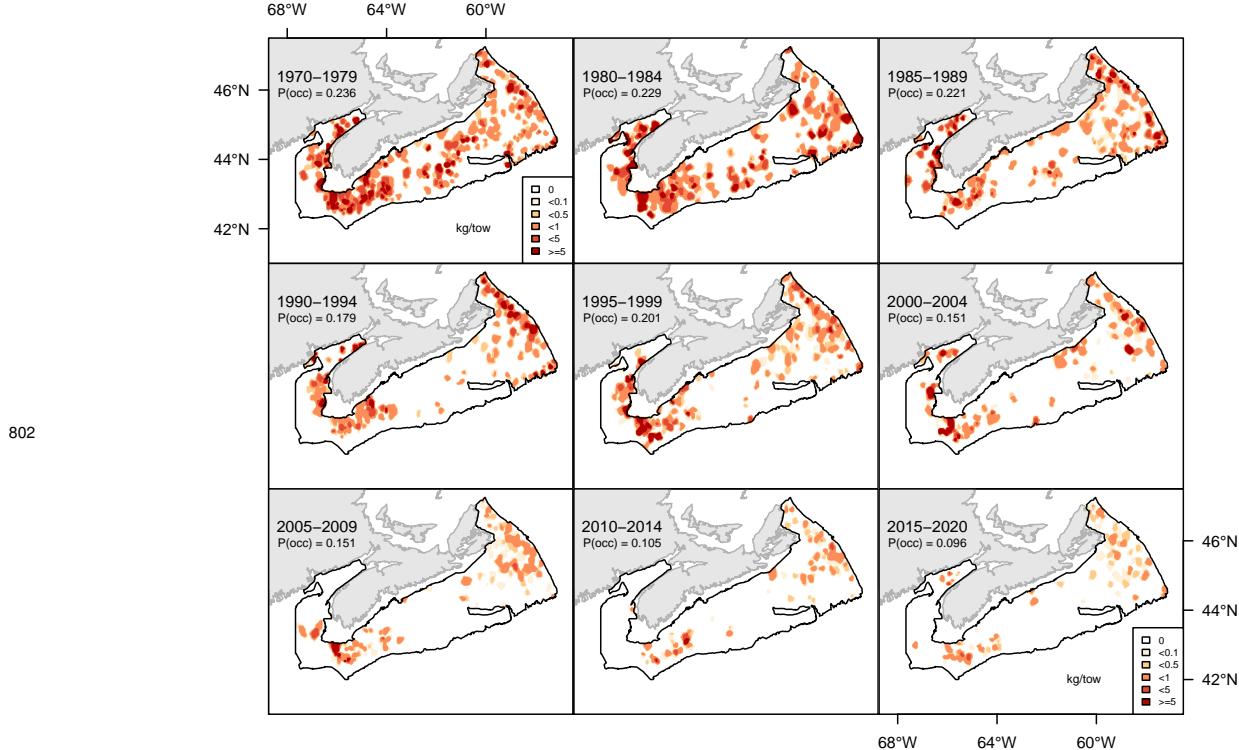


Figure 7.13A. Inverse distance weighted distribution of catch biomass (kg/tow) for Atlantic wolffish.

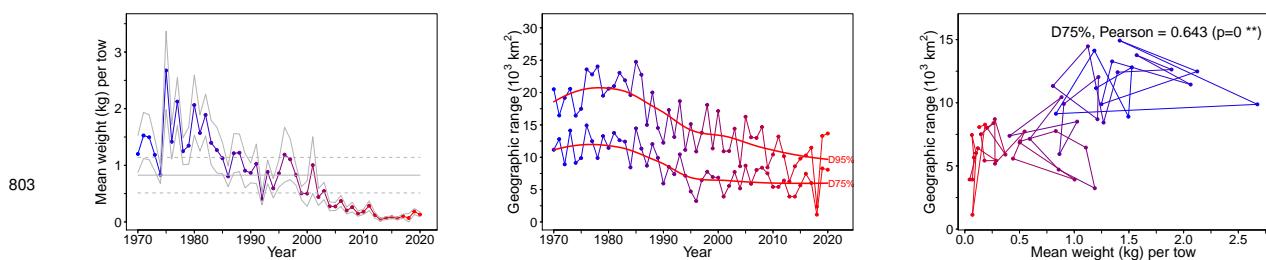


Figure 7.13B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Atlantic wolffish.

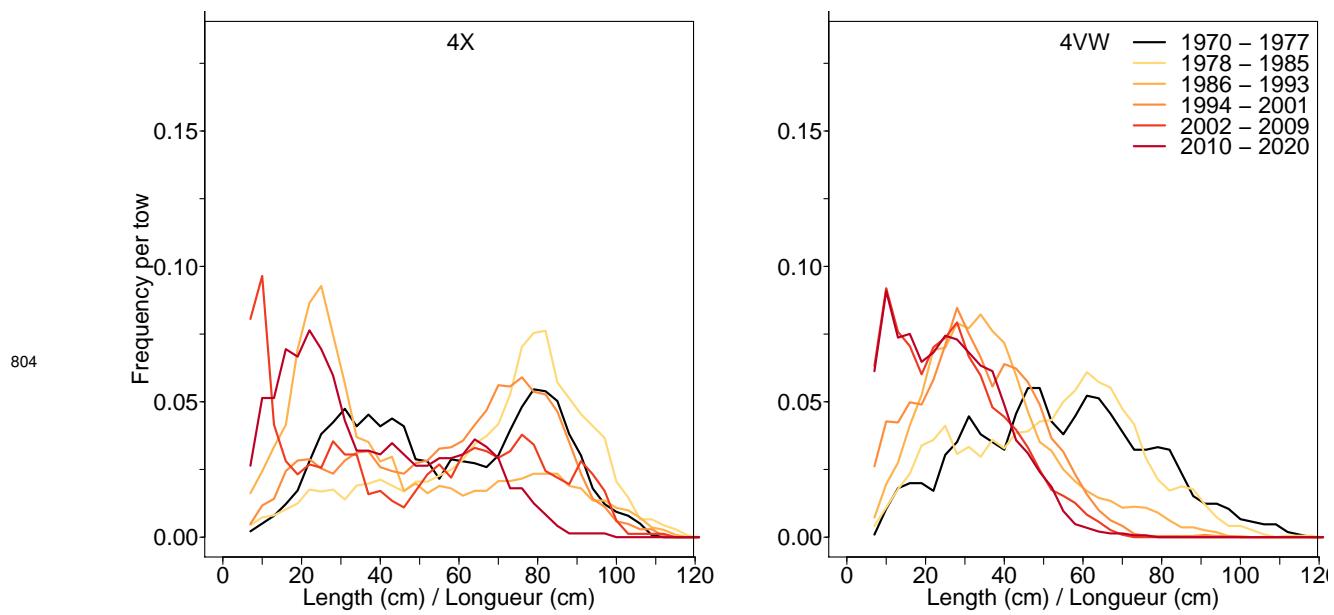


Figure 7.13C. Length frequency distribution in NAFO units 4X and 4VW for Atlantic wolffish.

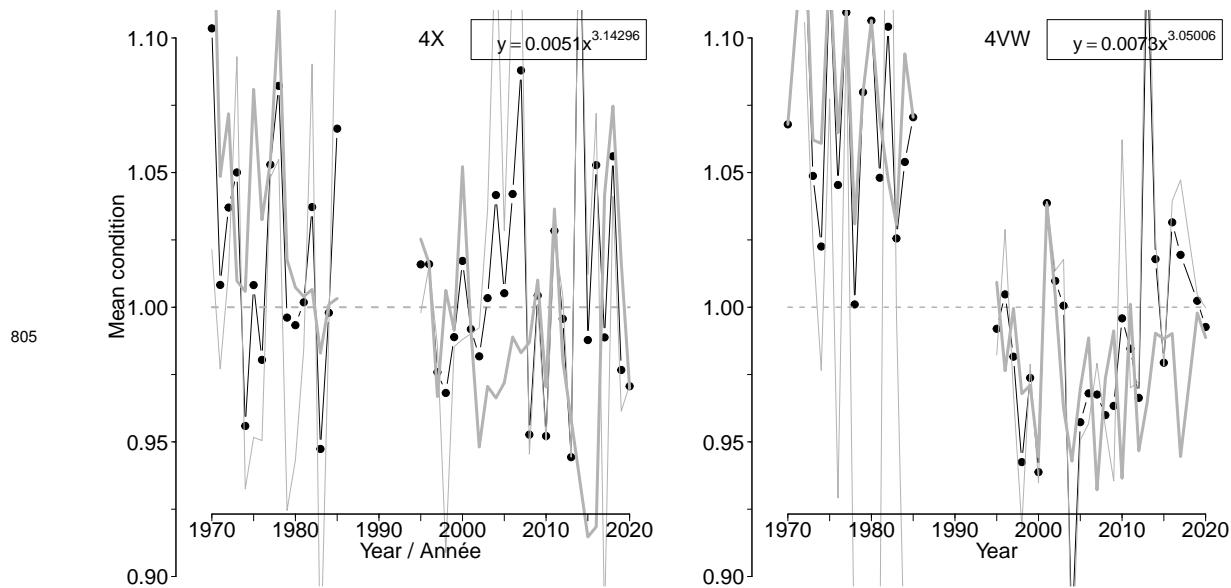
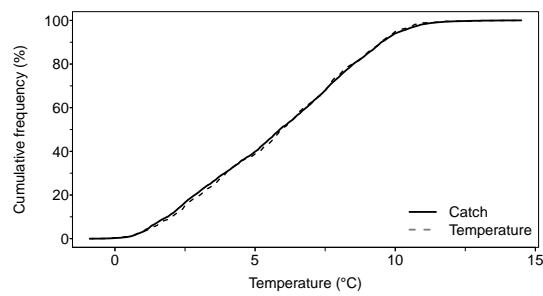
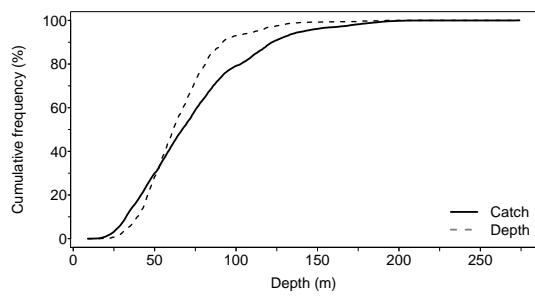
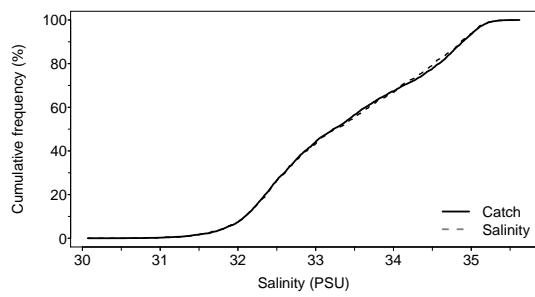


Figure 7.13D. Average fish condition in NAFO units 4X and 4VW for Atlantic wolffish.



806



Freq	Depth	Temp	Sal
F5	34	1.4	31.00
F25	49	3.6	32.48
F50	62	6.0	33.25
F75	77	8.1	34.33
F95	112	10.0	35.05

Figure 7.13E. Catch distribution by depth, temperature and salinity of Atlantic wolffish.

807

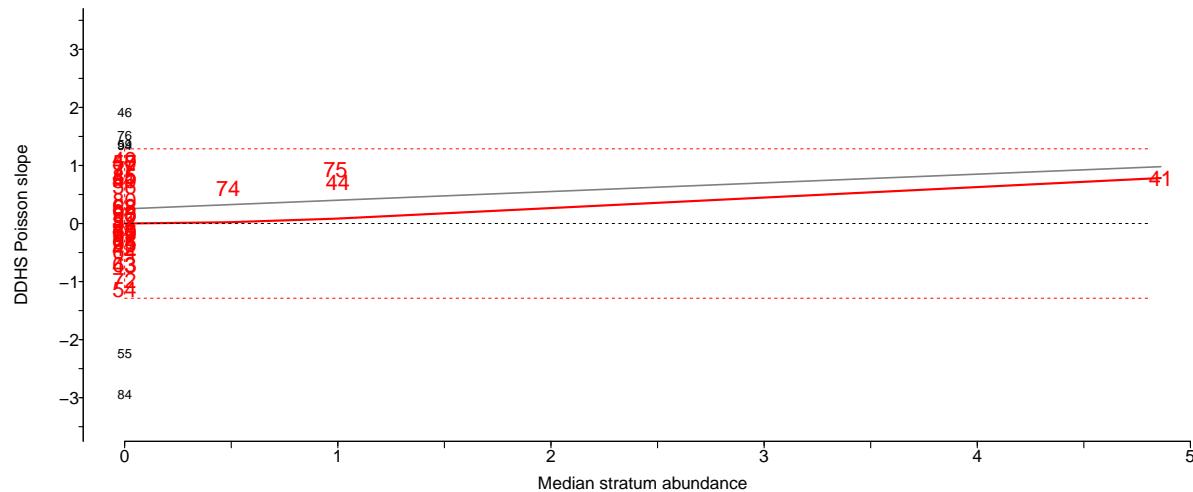


Figure 7.13F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Atlantic wolffish.

808

7.14 Atlantic herring (Hareng de l'Atlantique) - species code 60 (category LF)

809

Scientific name: [Clupea harengus](#)

810

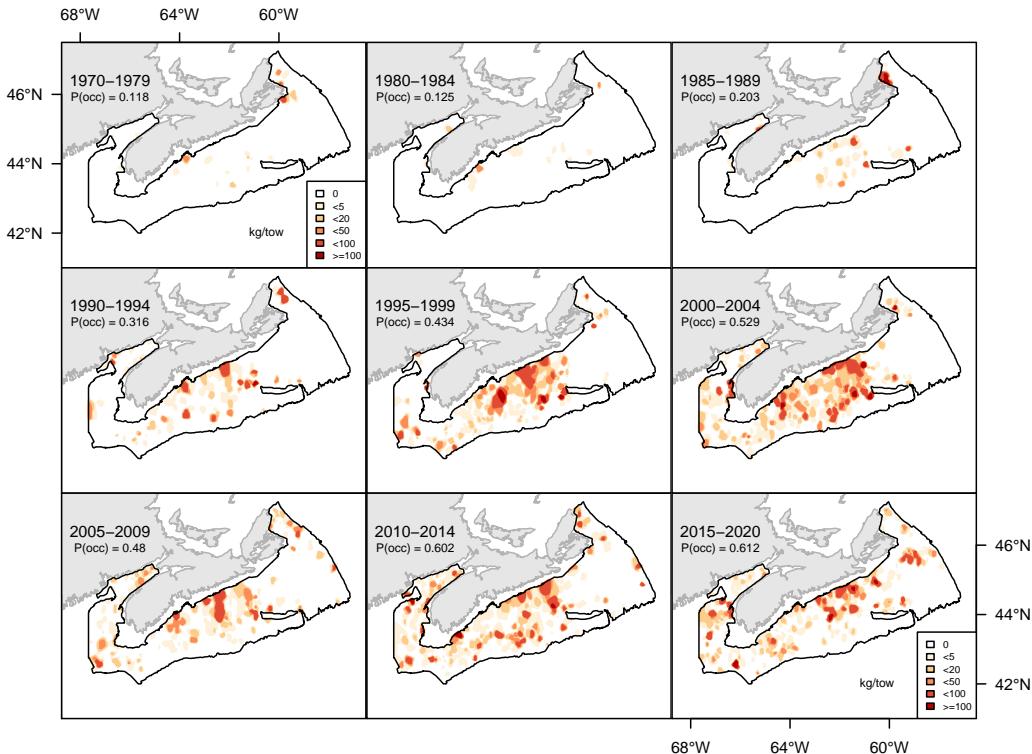


Figure 7.14A. Inverse distance weighted distribution of catch biomass (kg/tow) for Atlantic herring.

811

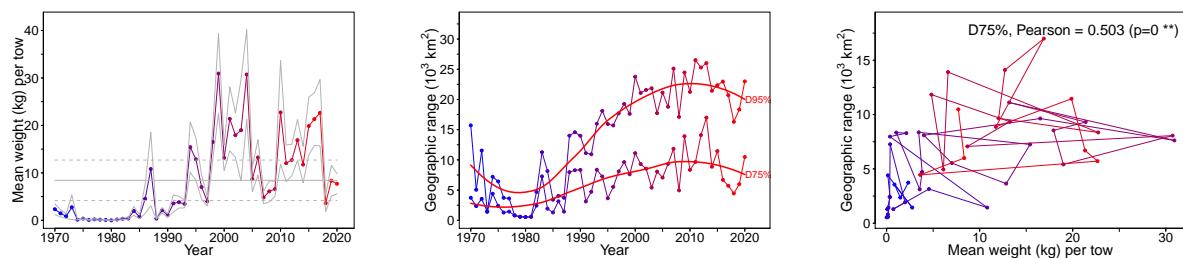


Figure 7.14B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Atlantic herring.

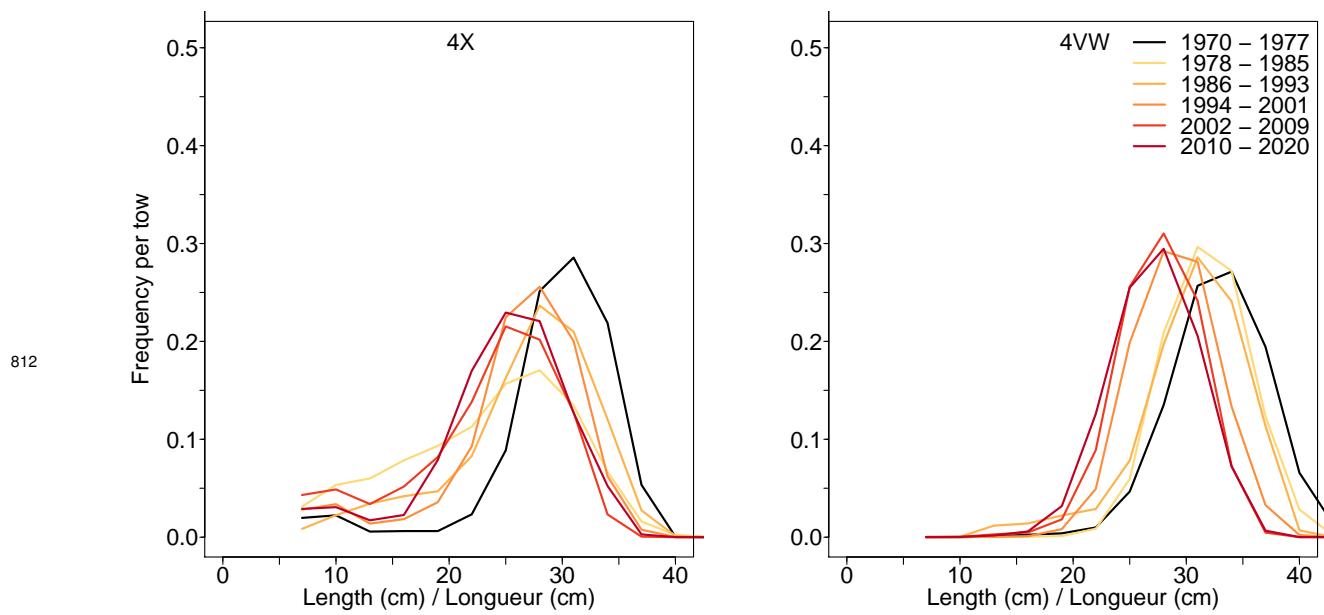


Figure 7.14C. Length frequency distribution in NAFO units 4X and 4VW for Atlantic herring.

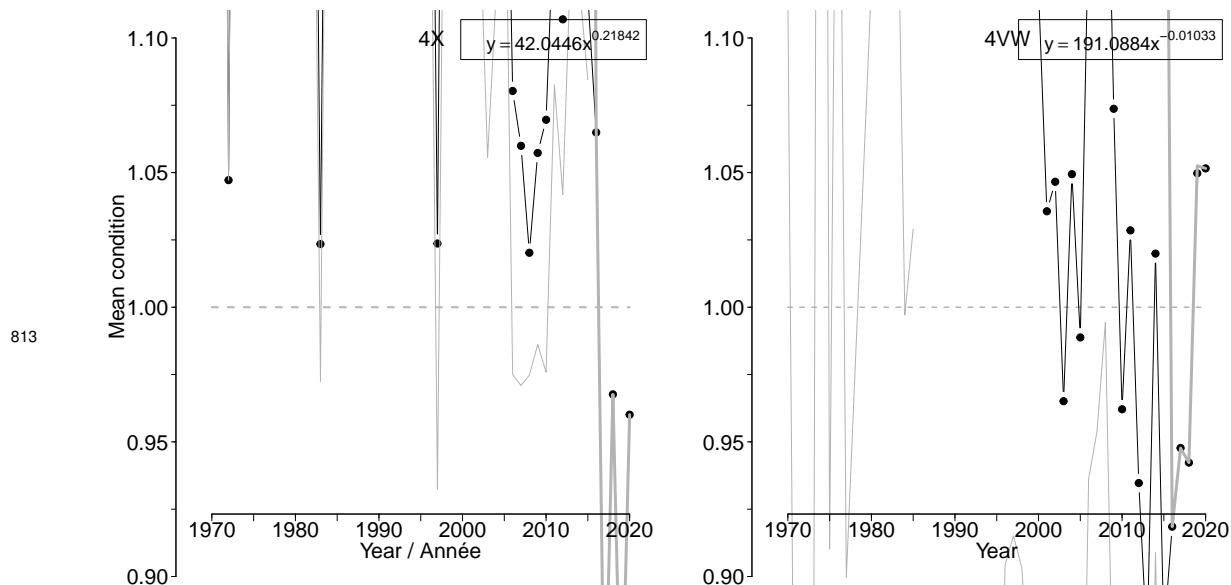
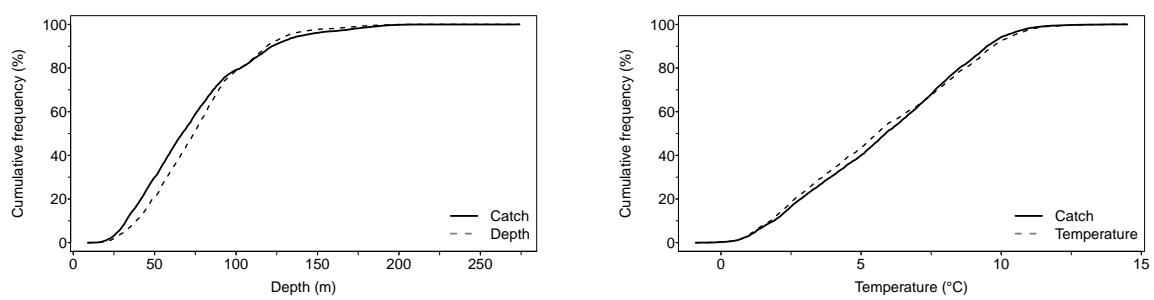
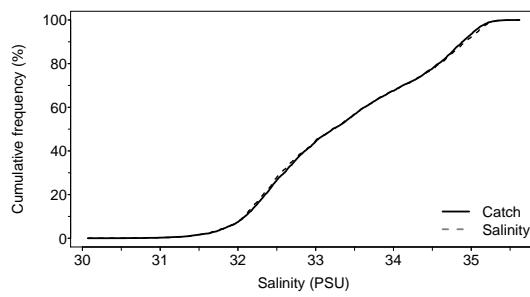


Figure 7.14D. Average fish condition in NAFO units 4X and 4VW for Atlantic herring.



814



Freq	Depth	Temp	Sal
F5	32	1.2	31.00
F25	54	3.2	32.45
F50	74	5.6	33.22
F75	95	8.3	34.38
F95	132	10.0	35.10

Figure 7.14E. Catch distribution by depth, temperature and salinity of Atlantic herring.

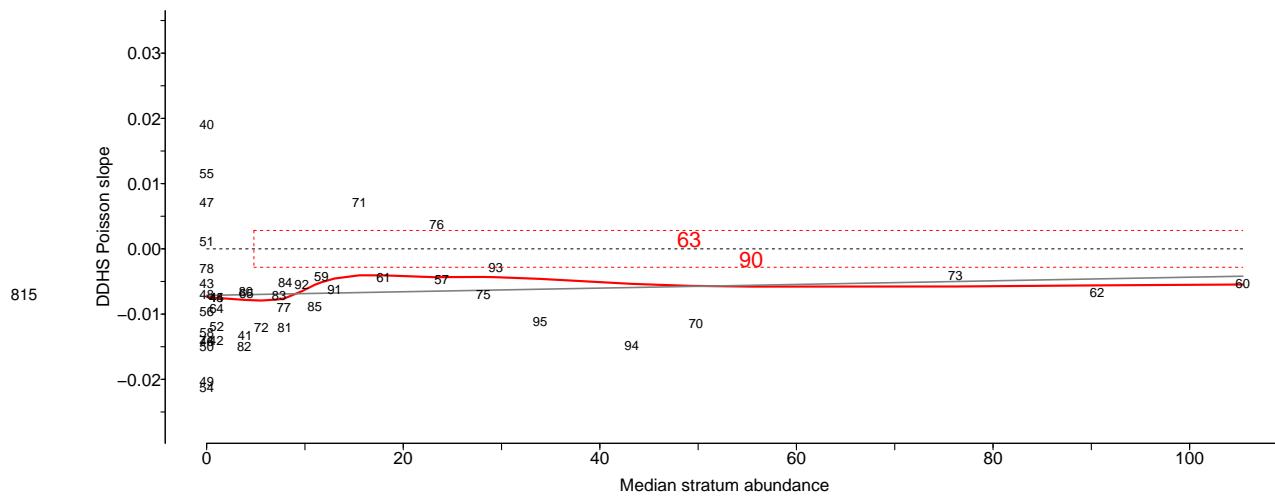


Figure 7.14F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Atlantic herring.

816 **7.15 Longhorn sculpin (Chaboisseau à dix-huit épines) - species code 300 (category**
 817 **LF)**

818 Scientific name: [Myoxocephalus octodecemspiniferus](#)

819

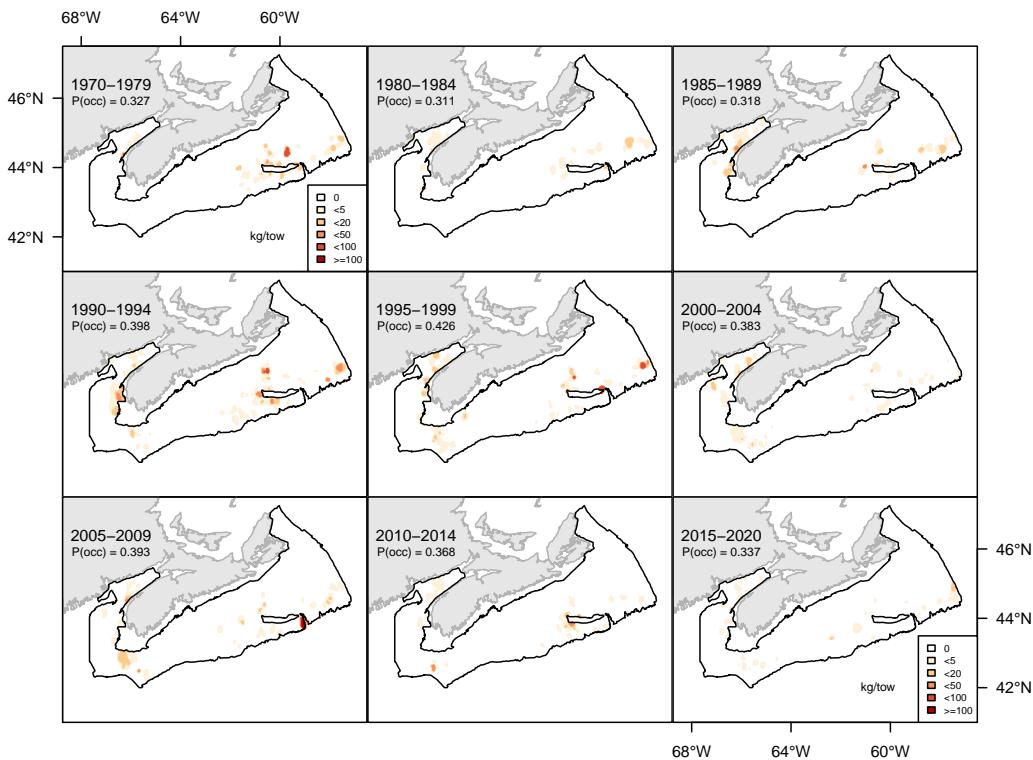


Figure 7.15A. Inverse distance weighted distribution of catch biomass (kg/tow) for Longhorn sculpin.

820

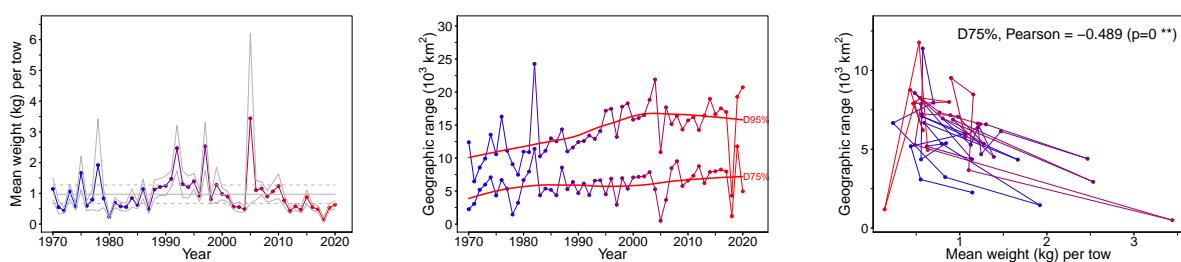


Figure 7.15B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Longhorn sculpin.

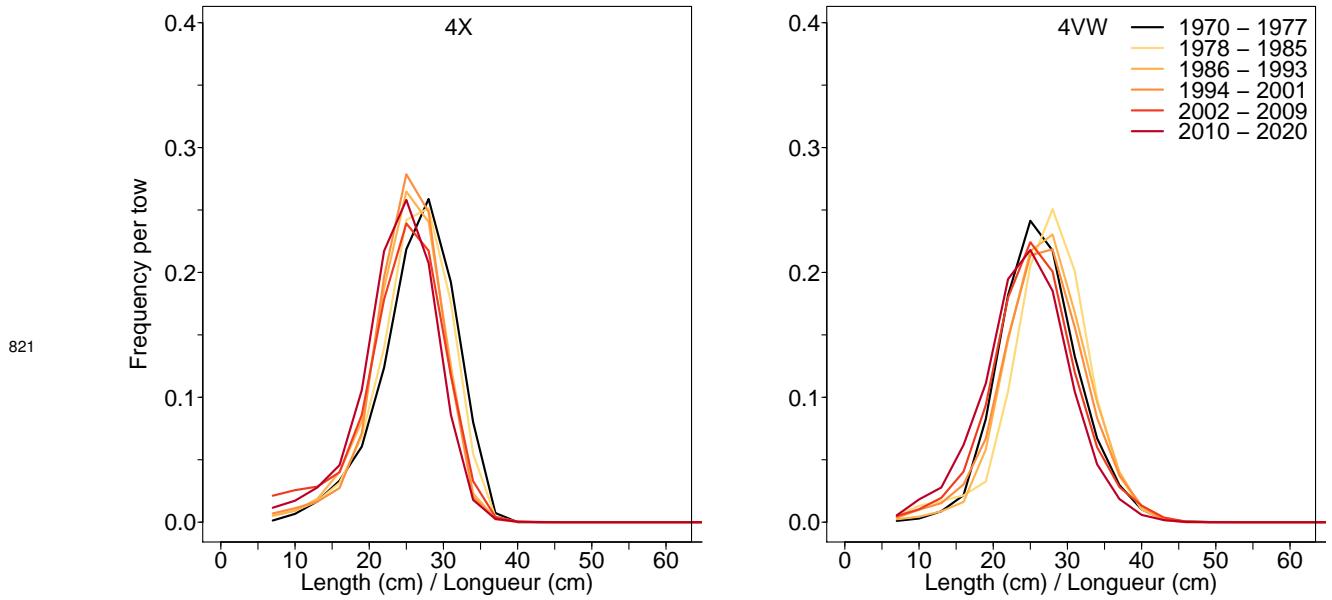


Figure 7.15C. Length frequency distribution in NAFO units 4X and 4VW for Longhorn sculpin.

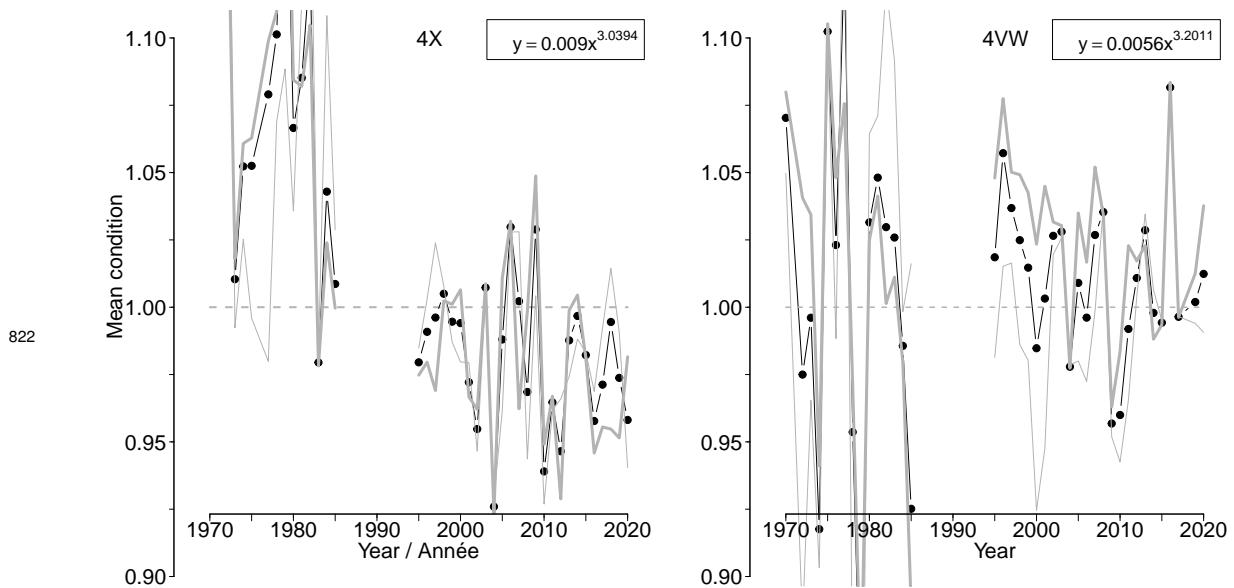
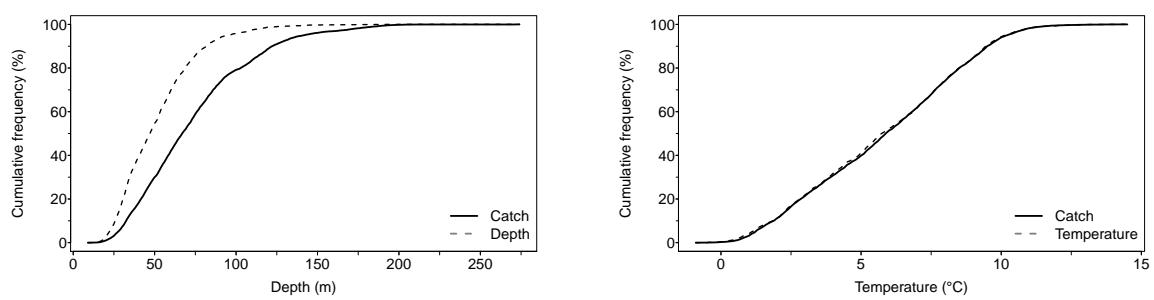
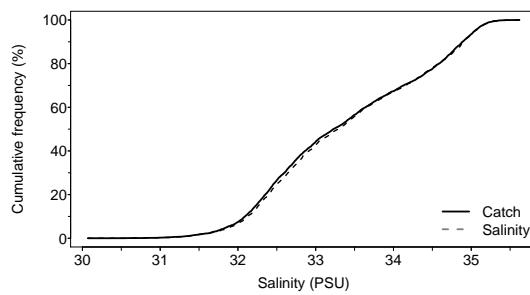


Figure 7.15D. Average fish condition in NAFO units 4X and 4VW for Longhorn sculpin.



823



Freq	Depth	Temp	Sal
F5	23	1.2	31.00
F25	33	3.3	32.51
F50	48	5.8	33.29
F75	64	8.1	34.38
F95	96	10.0	35.05

Figure 7.15E. Catch distribution by depth, temperature and salinity of Longhorn sculpin.

824

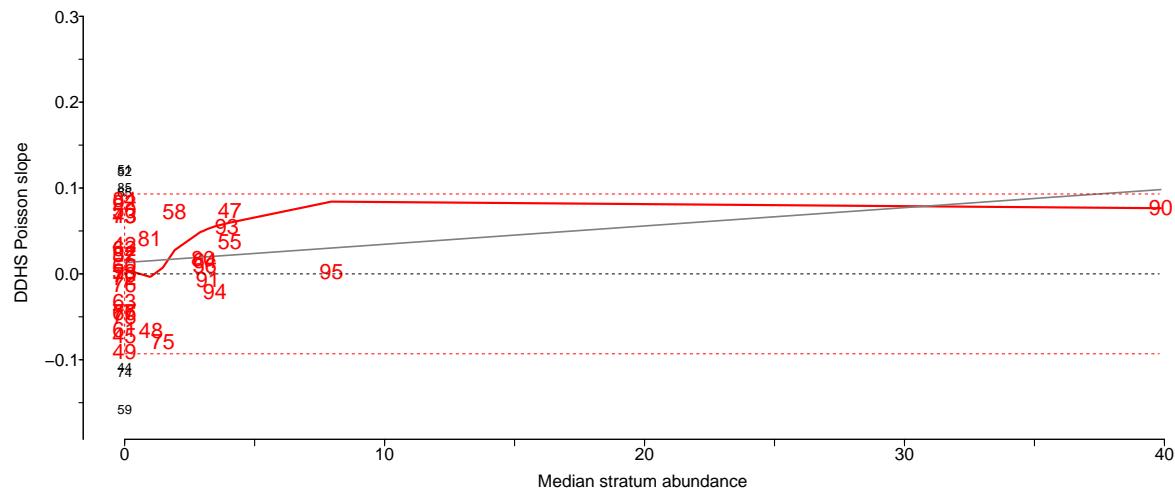


Figure 7.15F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Longhorn sculpin.

825

7.16 Moustache sculpin (Faux-trigle armé) - species code 304 (category LF)

826

Scientific name: [Triglops murrayi](#)

827

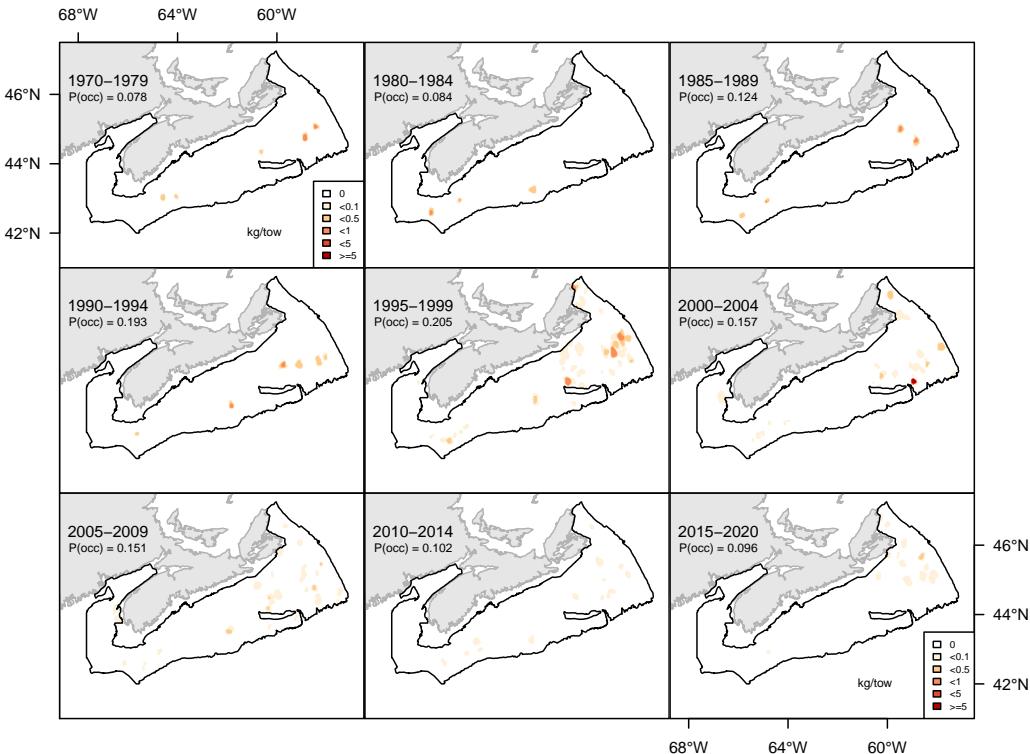


Figure 7.16A. Inverse distance weighted distribution of catch biomass (kg/tow) for Moustache sculpin.

828

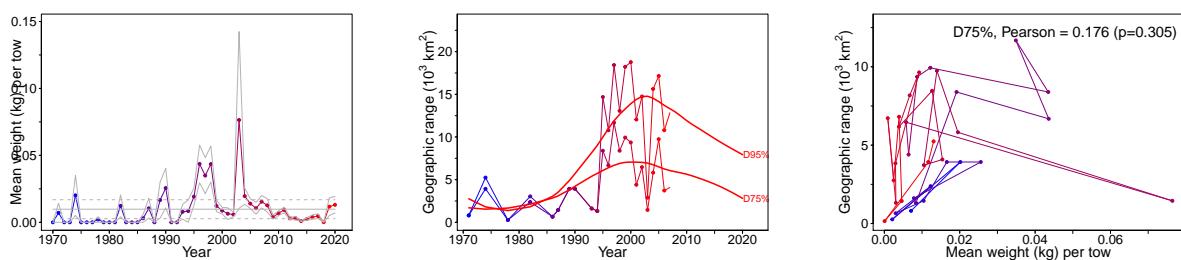


Figure 7.16B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Moustache sculpin.

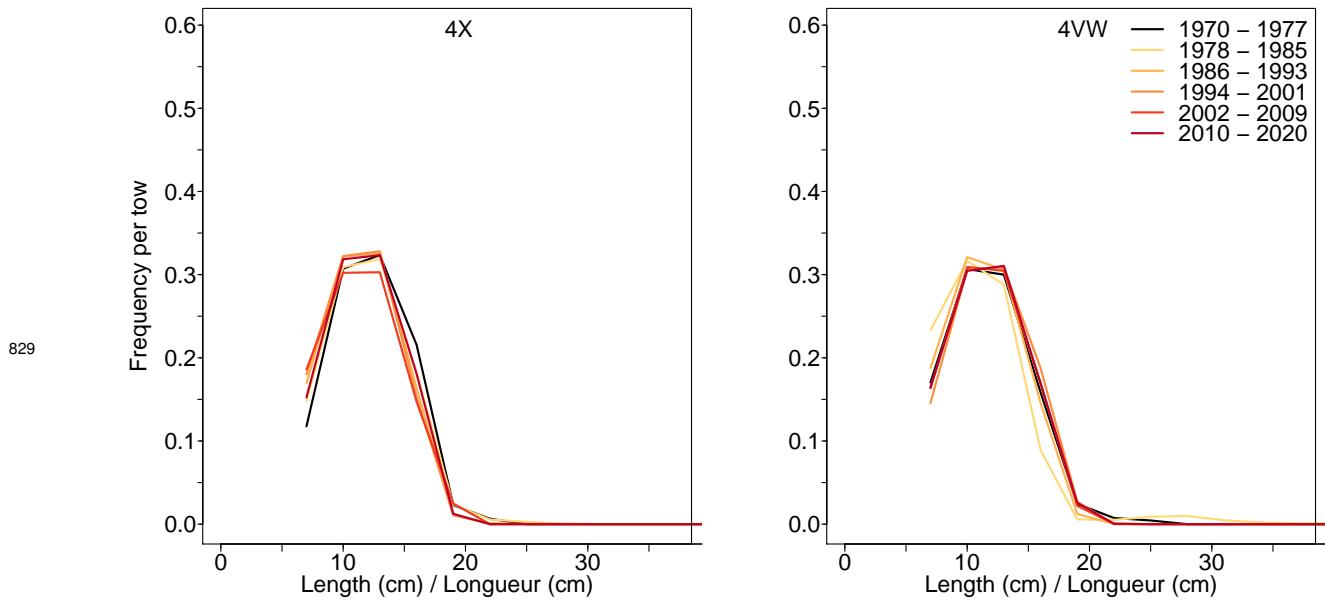


Figure 7.16C. Length frequency distribution in NAFO units 4X and 4VW for Moustache sculpin.

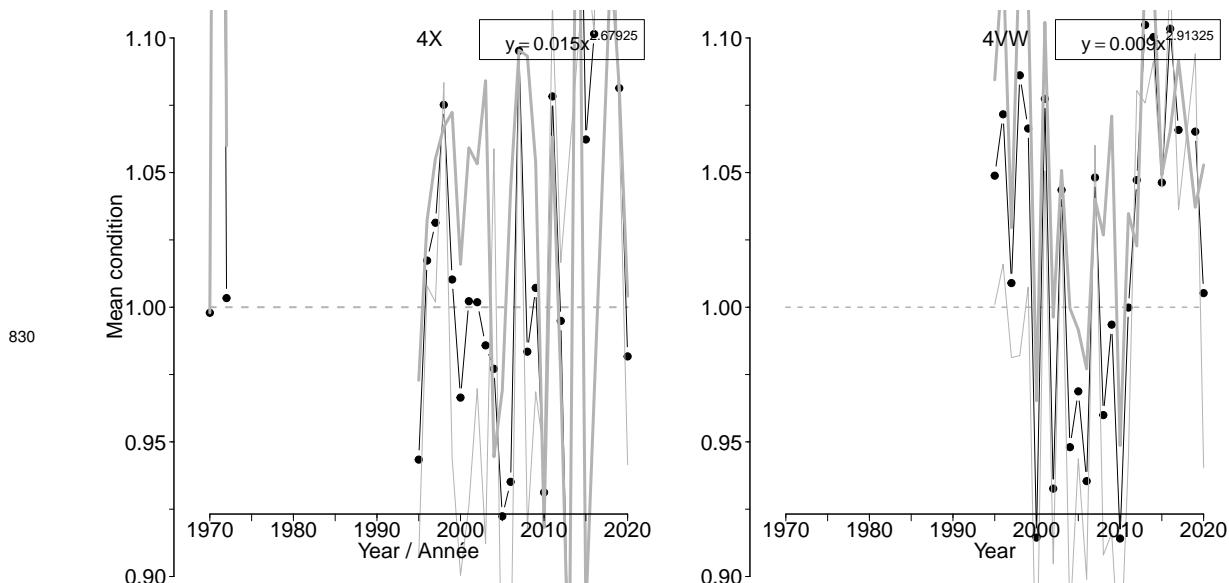
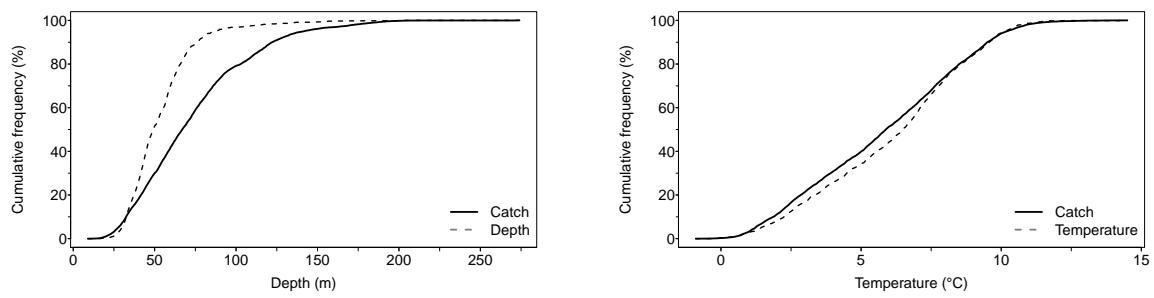
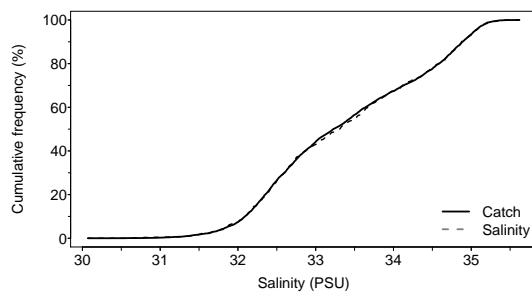


Figure 7.16D. Average fish condition in NAFO units 4X and 4VW for Moustache sculpin.



831



Freq	Depth	Temp	Sal
F5	30	1.5	31.00
F25	40	4.0	32.48
F50	50	6.5	33.31
F75	63	8.2	34.39
F95	88	10.0	35.06

Figure 7.16E. Catch distribution by depth, temperature and salinity of Moustache sculpin.

832

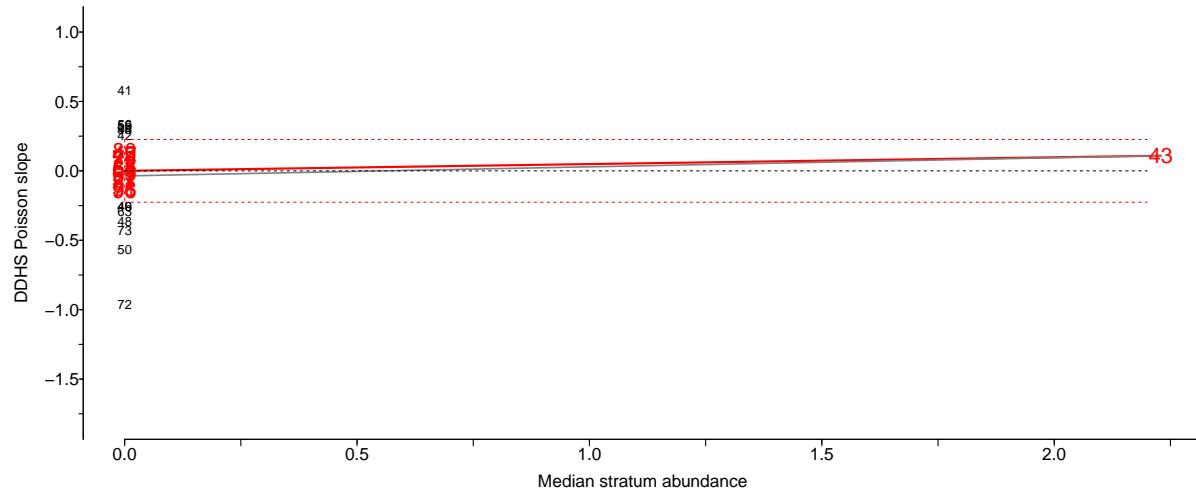


Figure 7.16F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Moustache sculpin.

833 **7.17 Sea raven (Hémithriptère atlantique) - species code 320 (category LF)**

834 Scientific name: [Hemitripterus americanus](#)

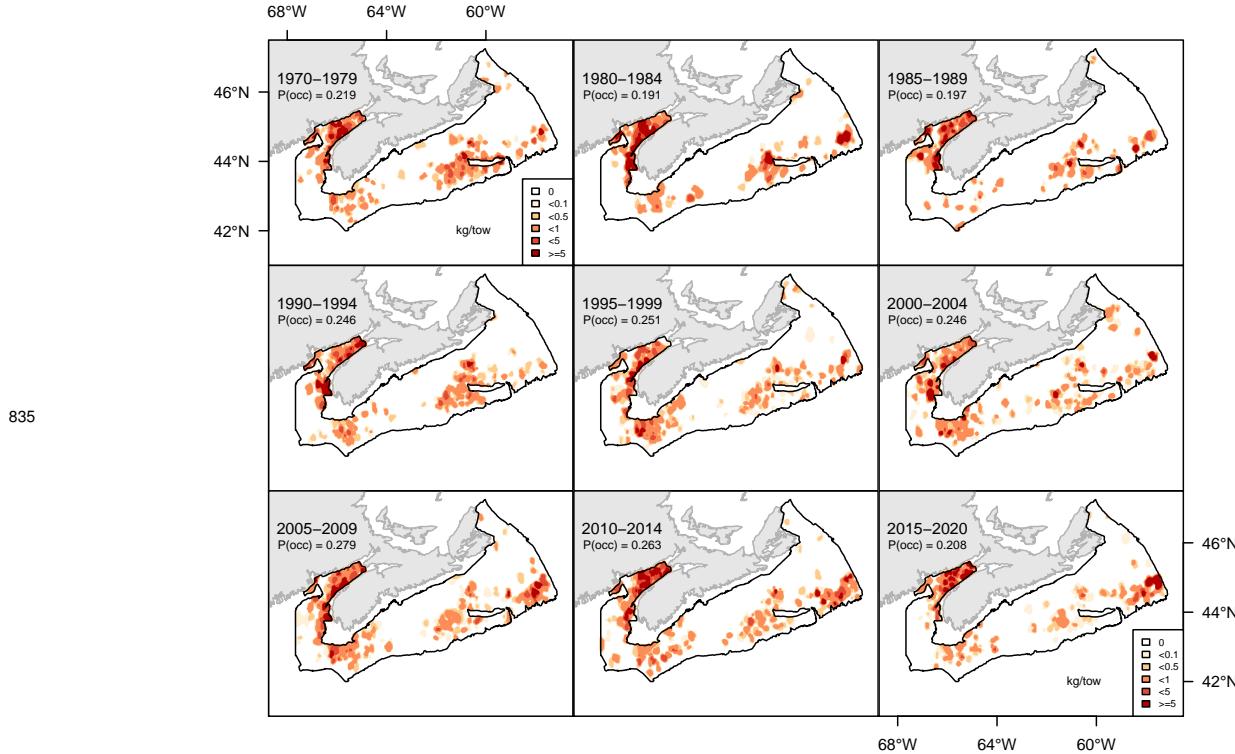


Figure 7.17A. Inverse distance weighted distribution of catch biomass (kg/tow) for Sea raven.

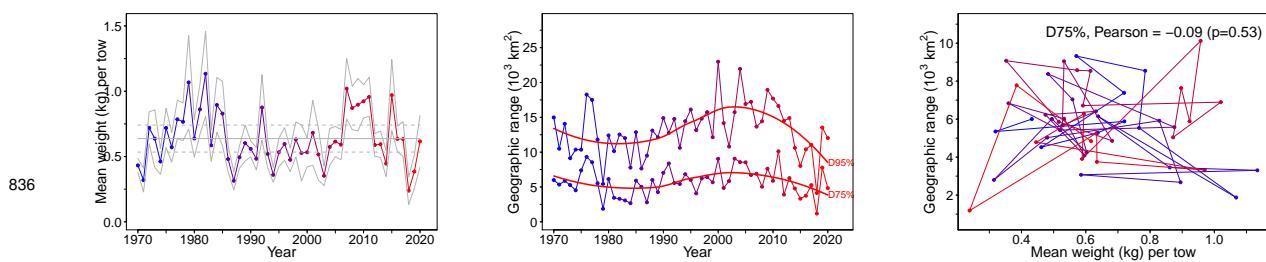


Figure 7.17B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Sea raven.

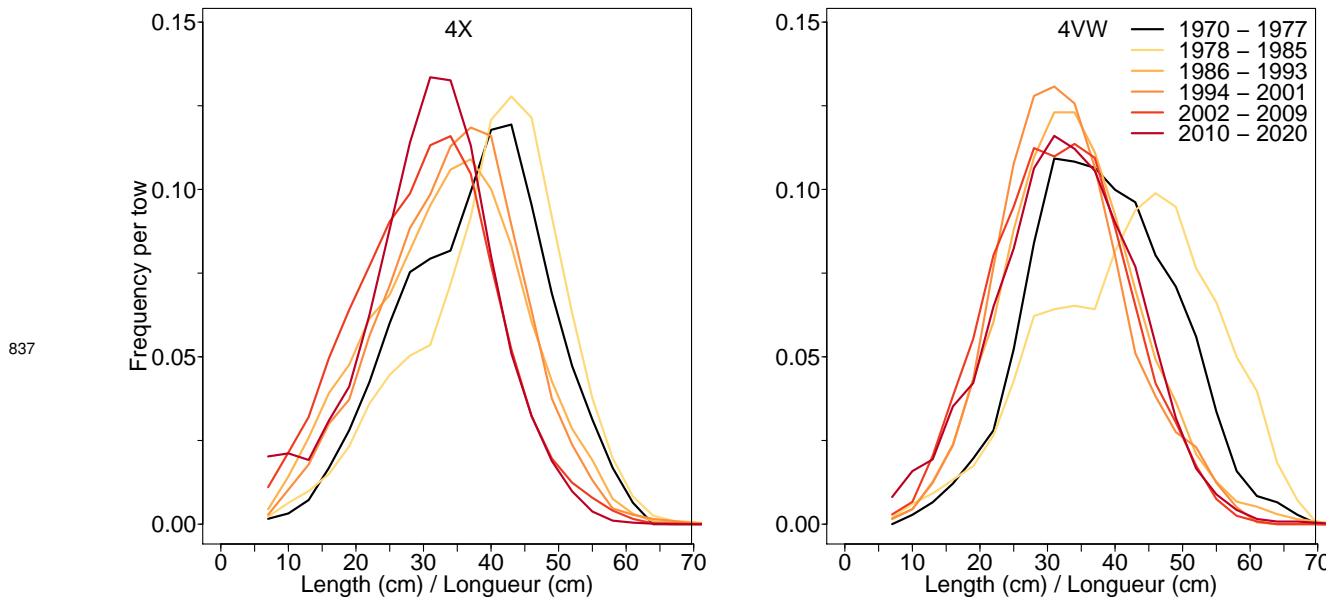


Figure 7.17C. Length frequency distribution in NAFO units 4X and 4VW for Sea raven.

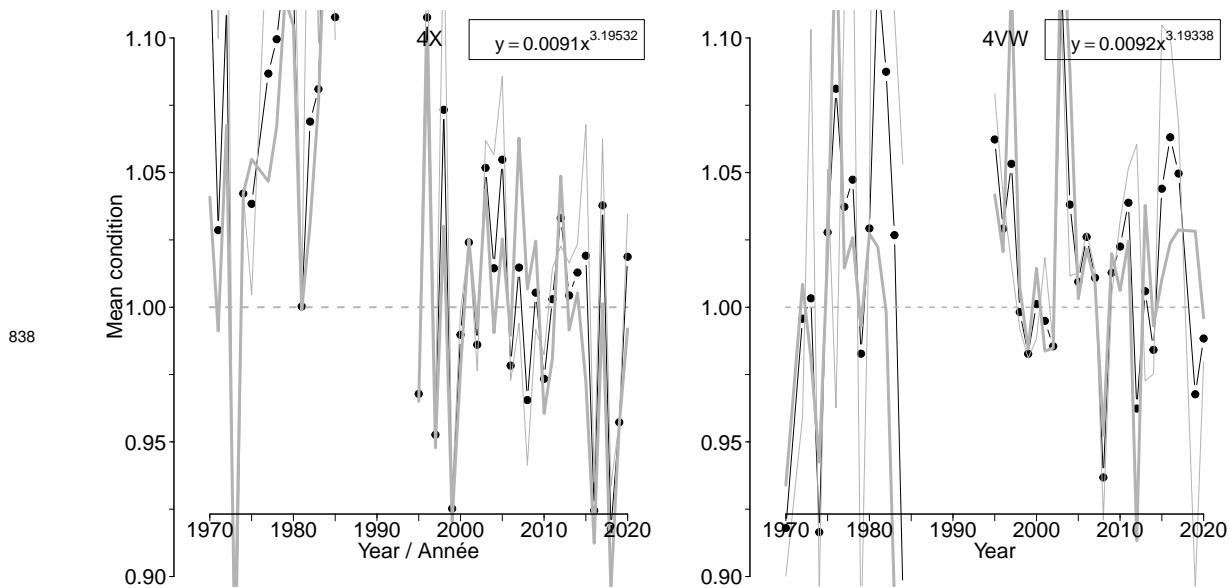
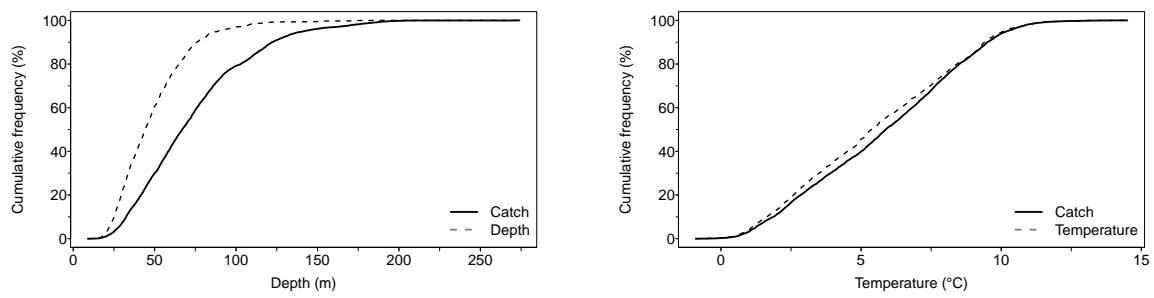
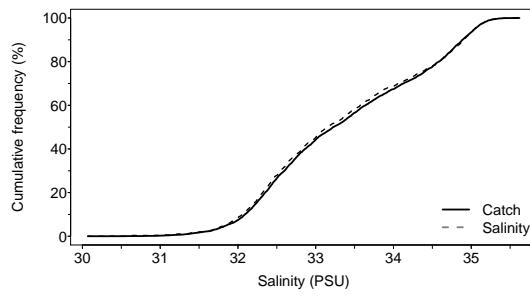


Figure 7.17D. Average fish condition in NAFO units 4X and 4VW for Sea raven.



839



Freq	Depth	Temp	Sal
F5	22	1.1	31.00
F25	32	3.1	32.43
F50	45	5.4	33.15
F75	61	8.0	34.35
F95	89	10.0	35.05

Figure 7.17E. Catch distribution by depth, temperature and salinity of Sea raven.

840

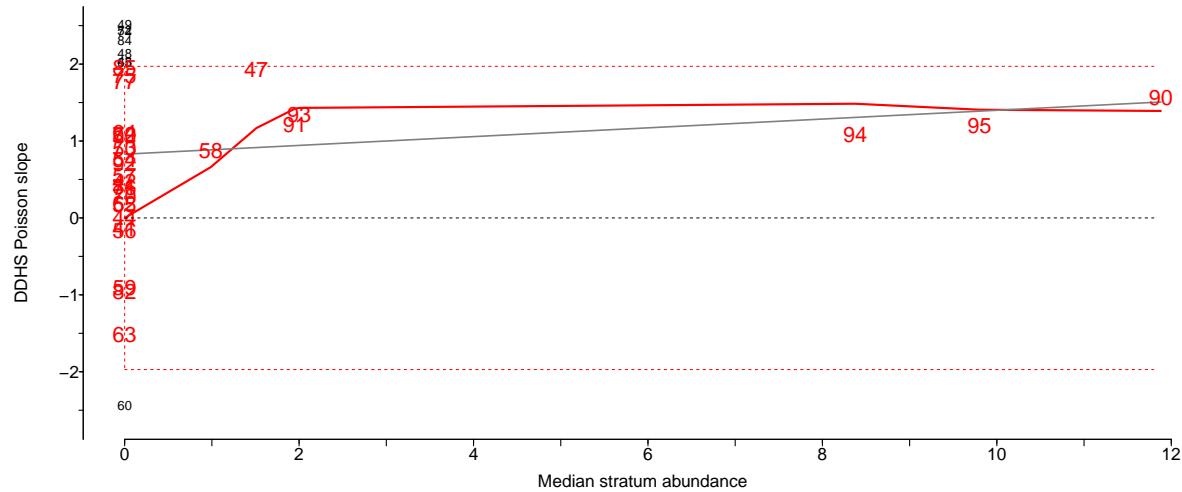


Figure 7.17F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Sea raven.

841

7.18 Alligatorfish (Poisson-alligator atlantique) - species code 340 (category LF)

842

Scientific name: [Aspidophoroides monopterygius](#)

843

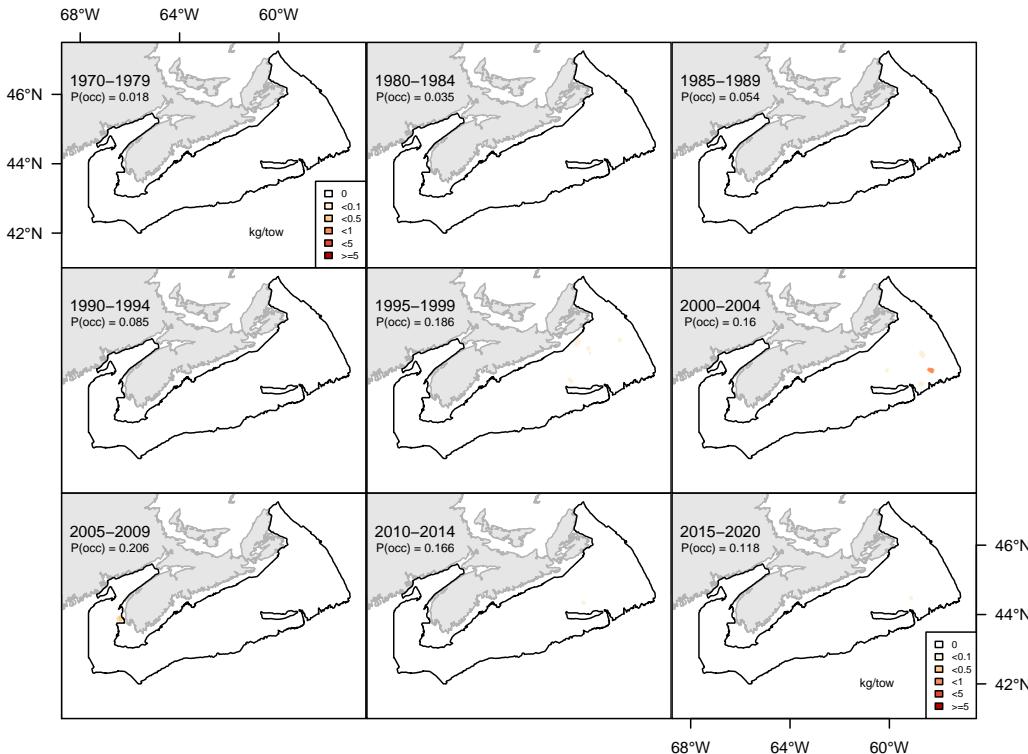


Figure 7.18A. Inverse distance weighted distribution of catch biomass (kg/tow) for Alligatorfish.

844

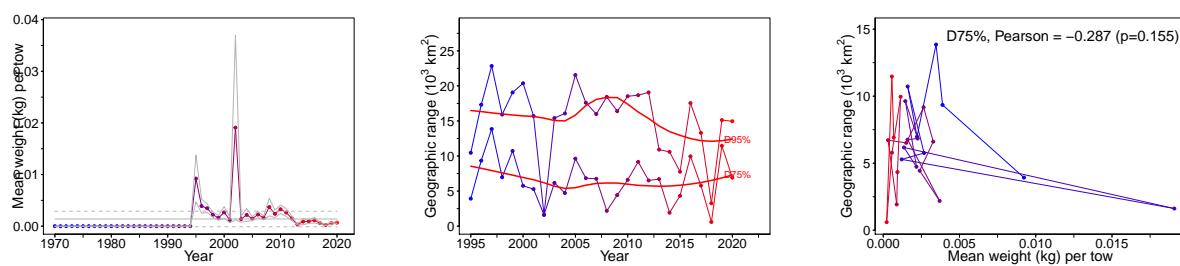


Figure 7.18B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Alligatorfish.

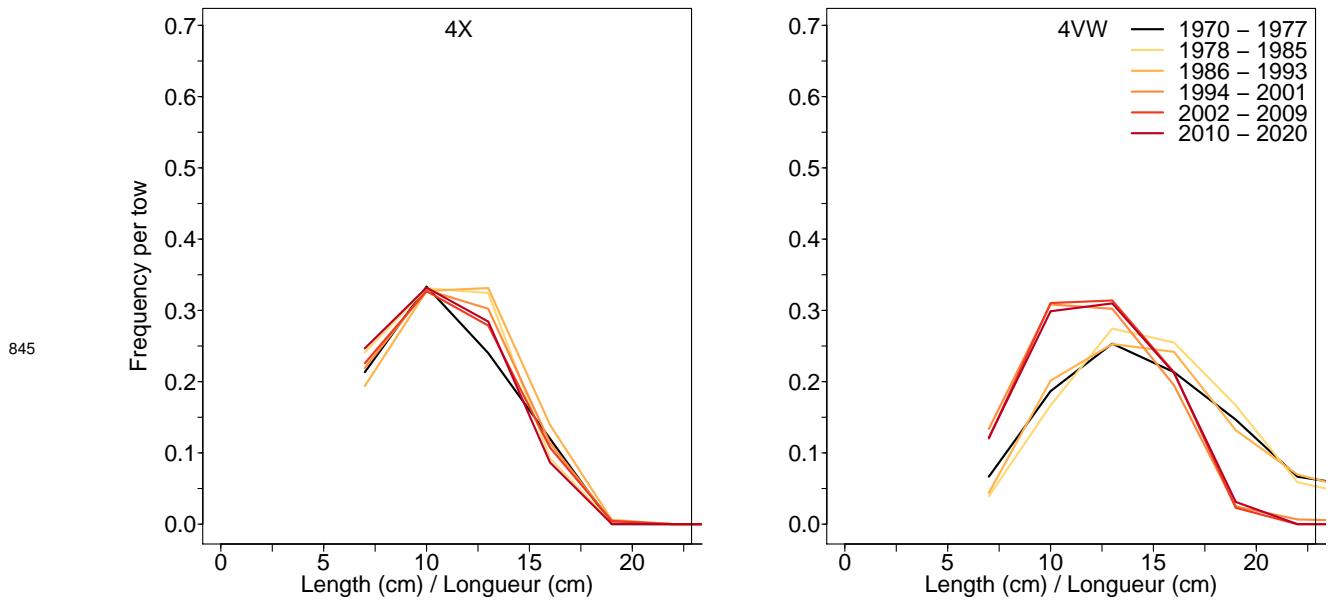


Figure 7.18C. Length frequency distribution in NAFO units 4X and 4VW for Alligatorfish.

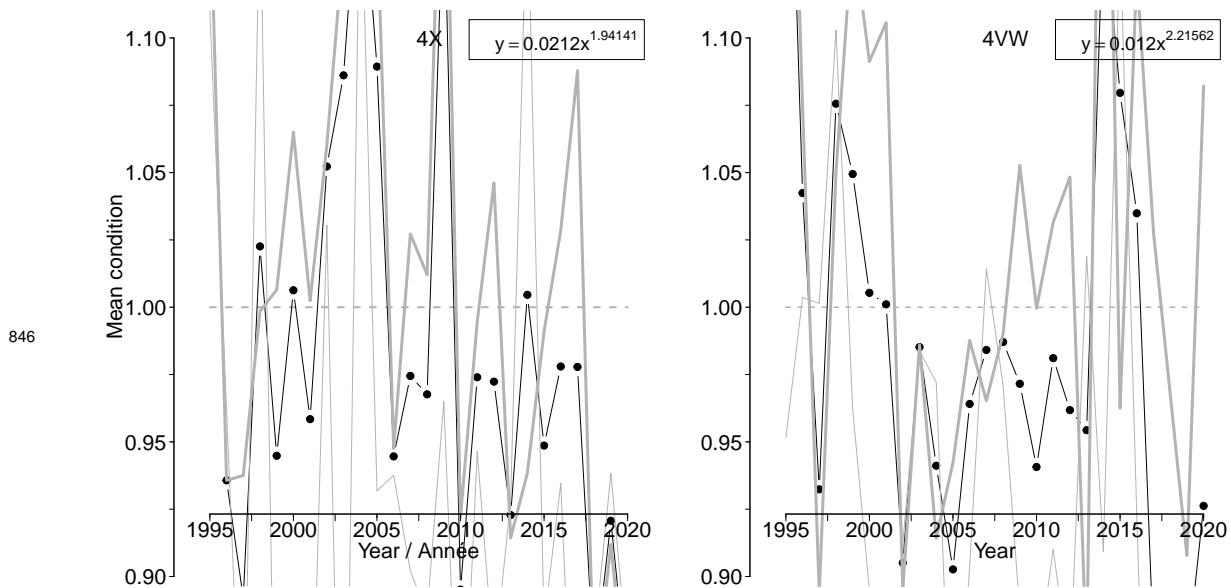
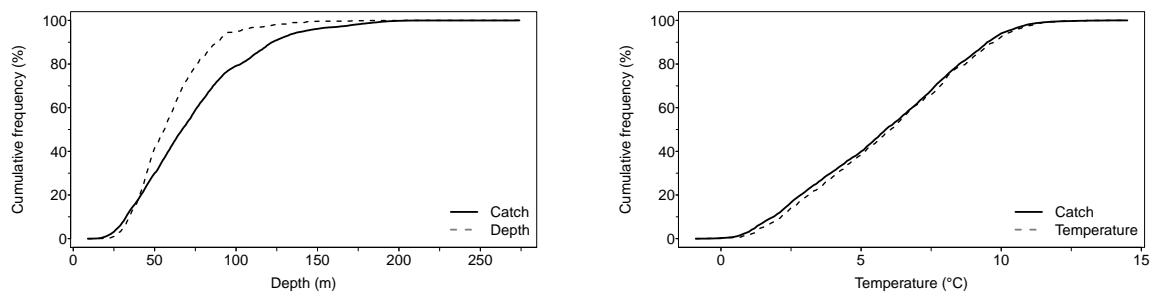
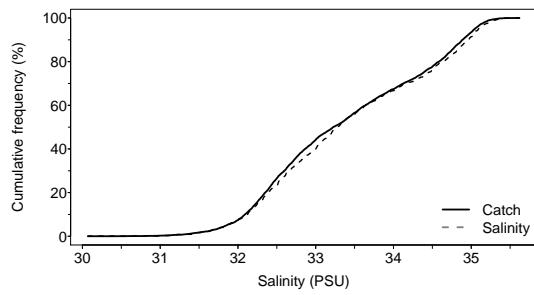


Figure 7.18D. Average fish condition in NAFO units 4X and 4VW for Alligatorfish.



847



Freq	Depth	Temp	Sal
F5	32	1.5	31.00
F25	44	3.7	32.53
F50	57	6.1	33.28
F75	72	8.2	34.45
F95	102	10.0	35.10

Figure 7.18E. Catch distribution by depth, temperature and salinity of Alligatorfish.

848

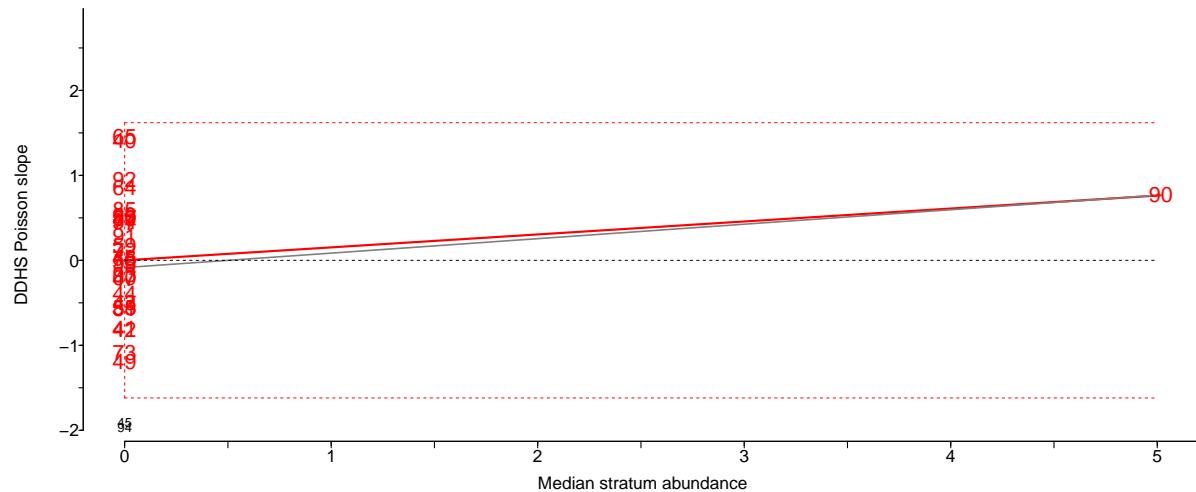


Figure 7.18F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Alligatorfish.

849

7.19 Monkfish (Baudroie d'Amérique) - species code 400 (category LF)

850

Scientific name: [Lophius americanus](#)

851

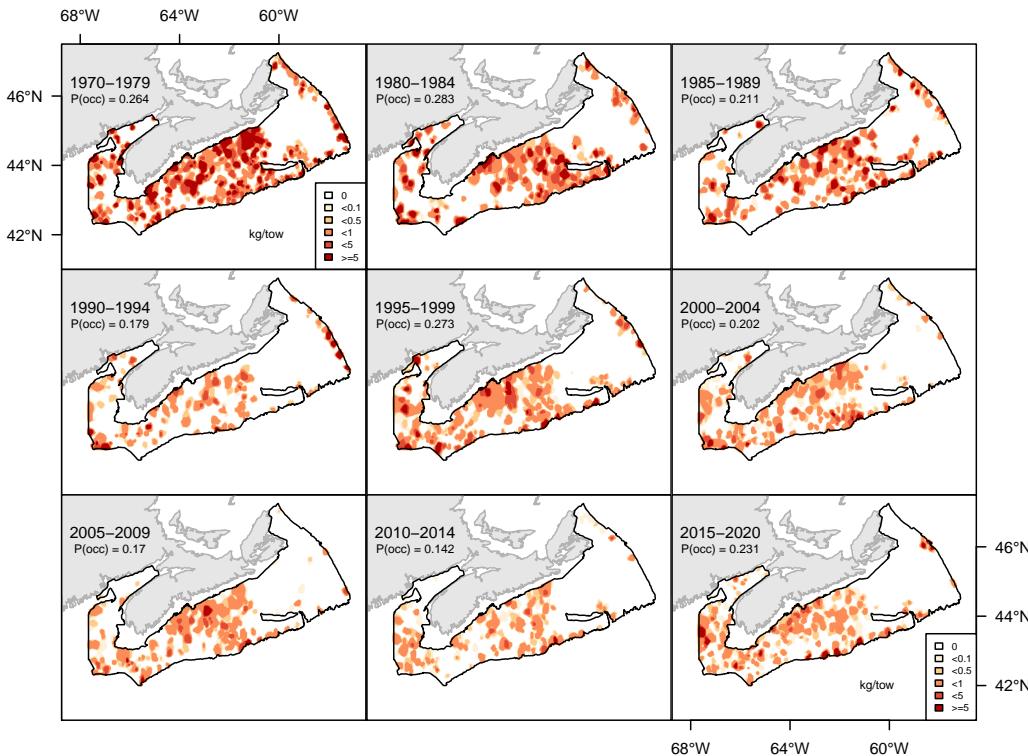


Figure 7.19A. Inverse distance weighted distribution of catch biomass (kg/tow) for Monkfish.

852

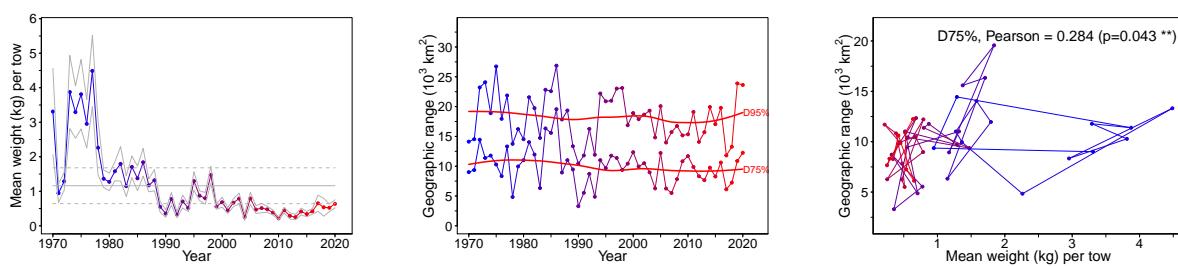


Figure 7.19B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Monkfish.

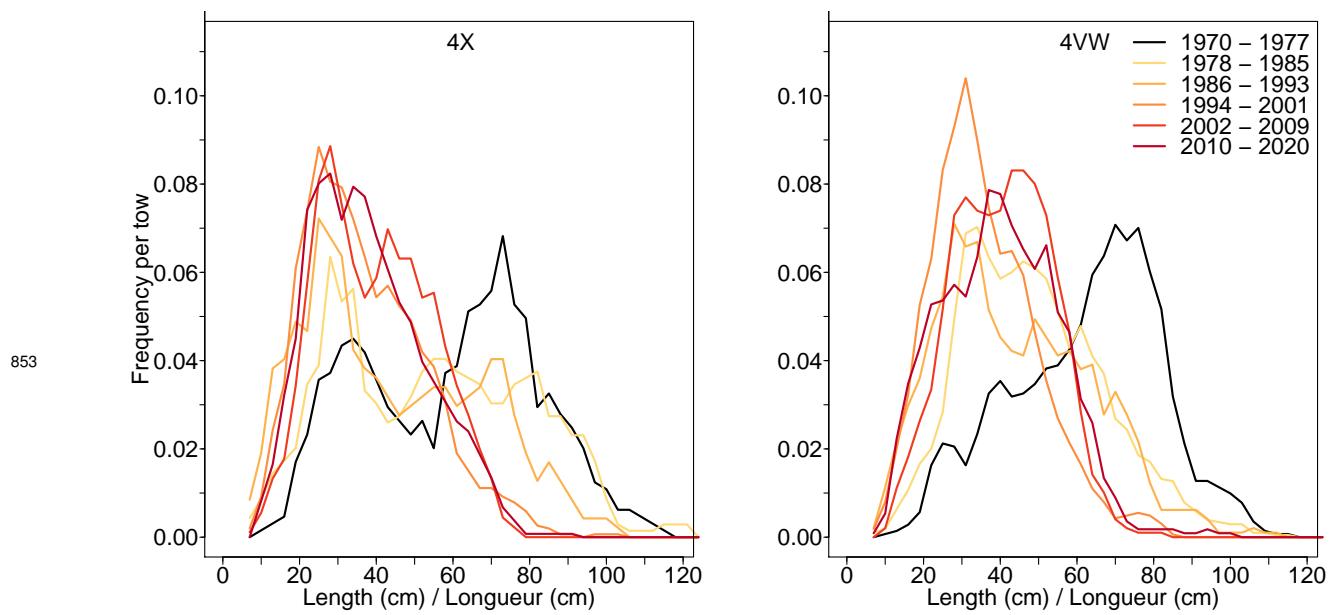


Figure 7.19C. Length frequency distribution in NAFO units 4X and 4VW for Monkfish.

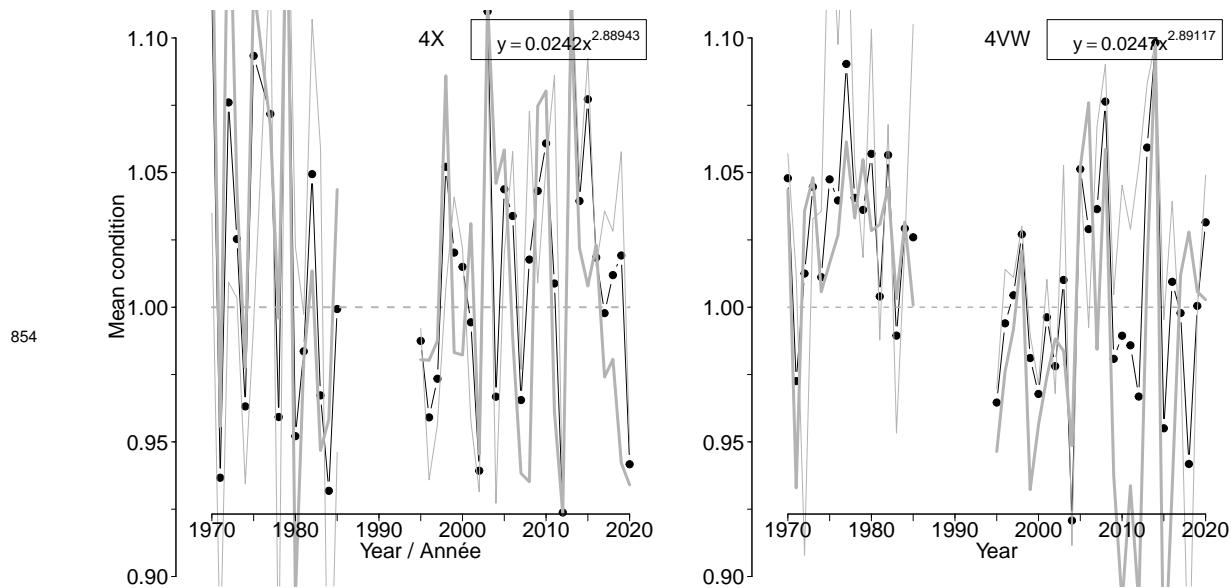
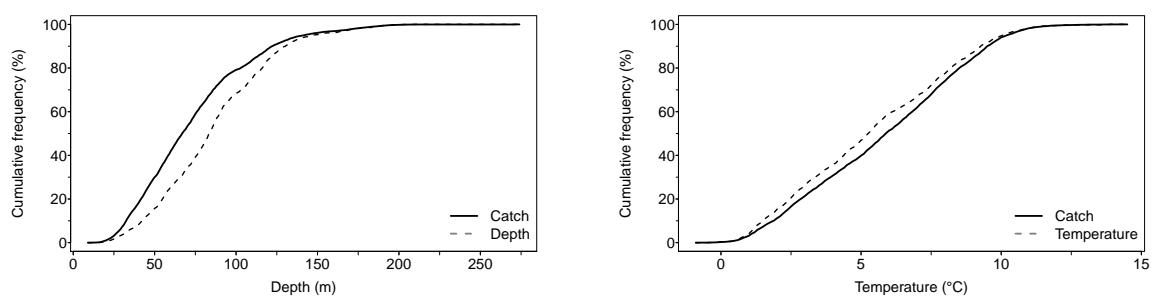
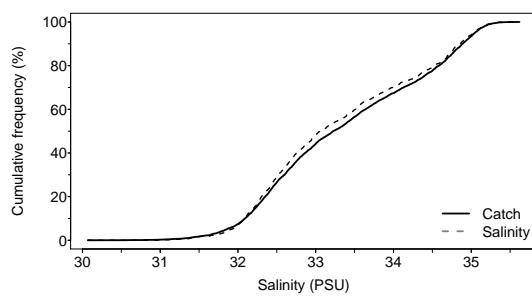


Figure 7.19D. Average fish condition in NAFO units 4X and 4VW for Monkfish.



855



Freq	Depth	Temp	Sal
F5	33	1.1	31.00
F25	60	2.9	32.43
F50	84	5.3	33.07
F75	110	7.8	34.31
F95	148	10.0	35.03

Figure 7.19E. Catch distribution by depth, temperature and salinity of Monkfish.

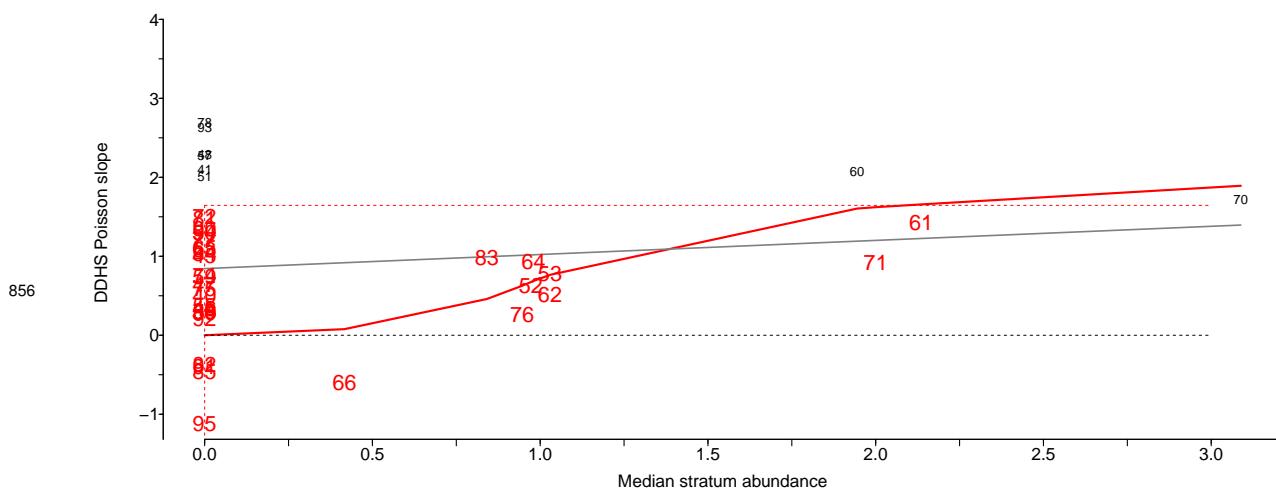


Figure 7.19F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Monkfish.

857

7.20 Ocean pout (Loquette d'Amérique) - species code 640 (category LF)

858

Scientific name: [Zoarces americanus](#)

859

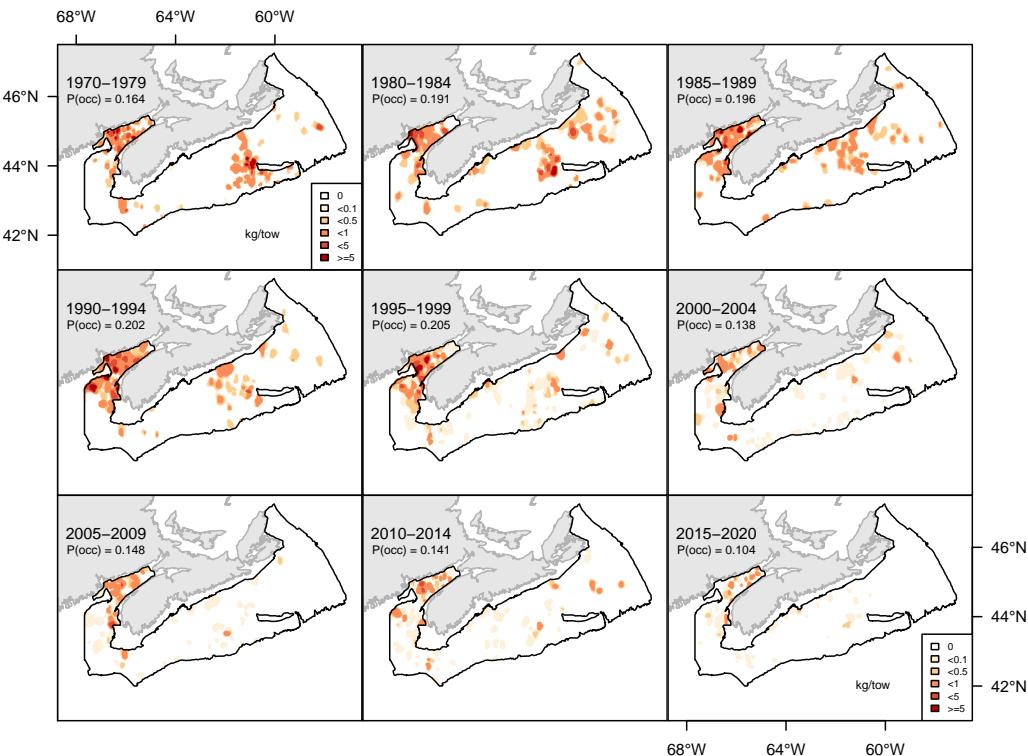


Figure 7.20A. Inverse distance weighted distribution of catch biomass (kg/tow) for Ocean pout.

860

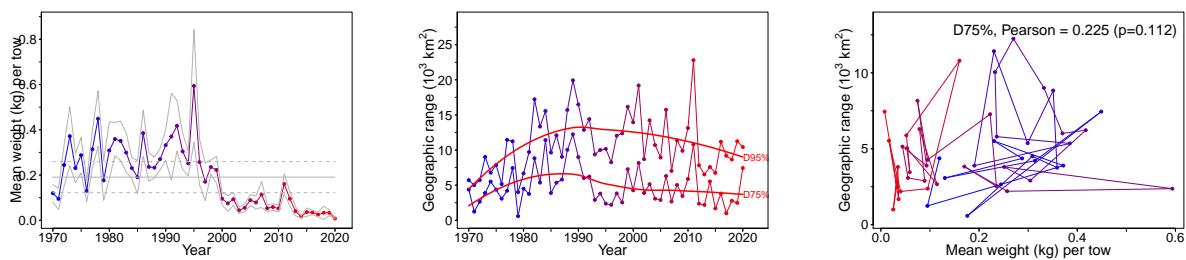


Figure 7.20B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Ocean pout.

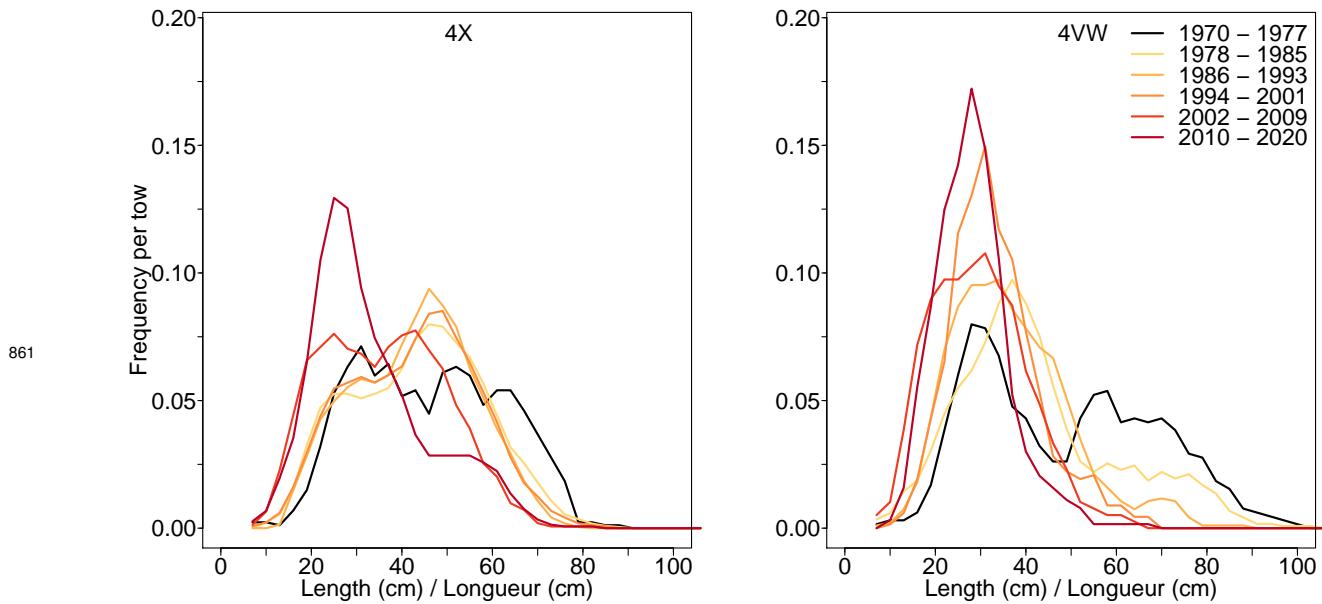


Figure 7.20C. Length frequency distribution in NAFO units 4X and 4VW for Ocean pout.

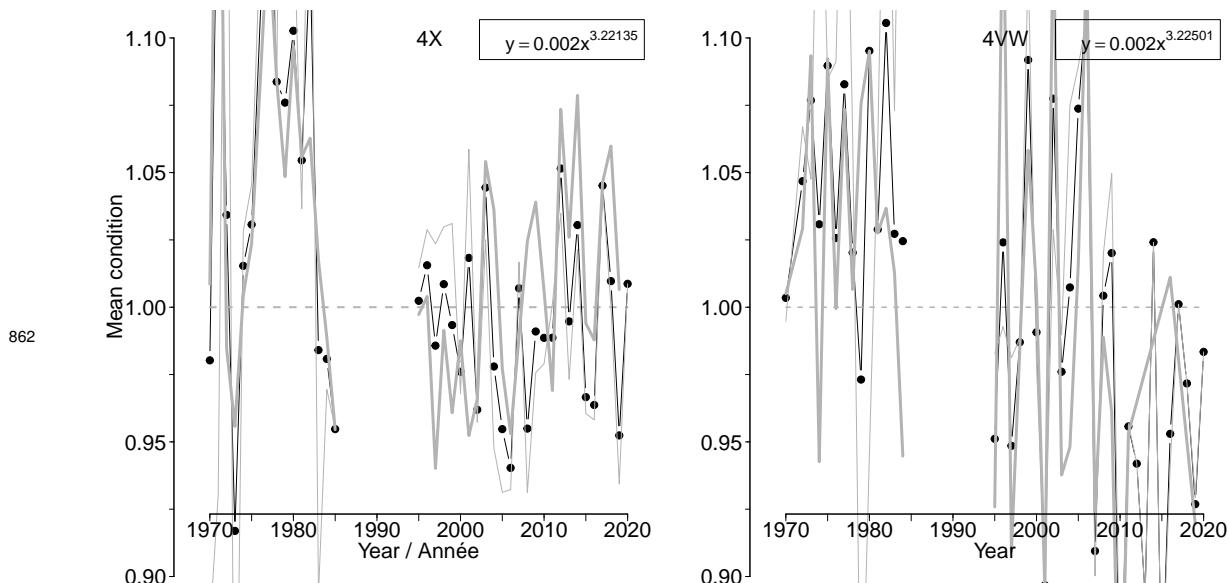
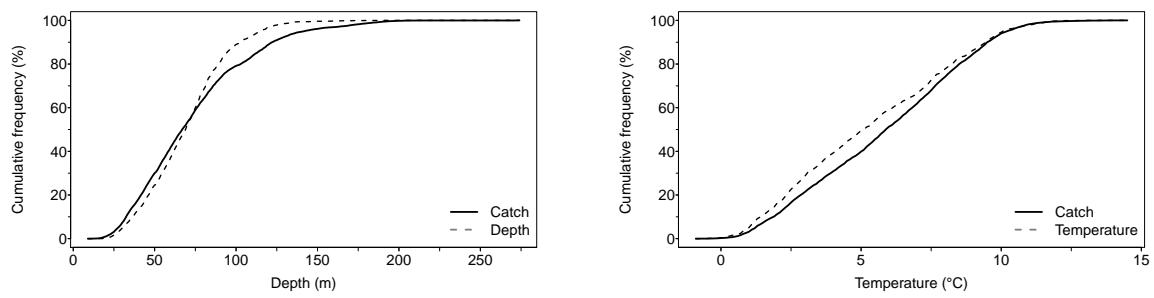
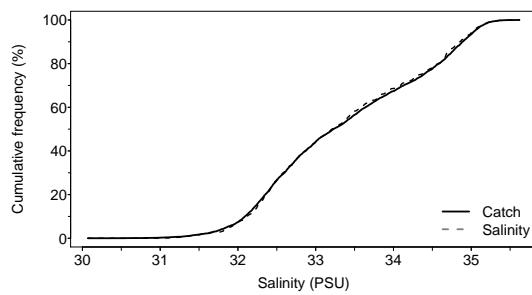


Figure 7.20D. Average fish condition in NAFO units 4X and 4VW for Ocean pout.

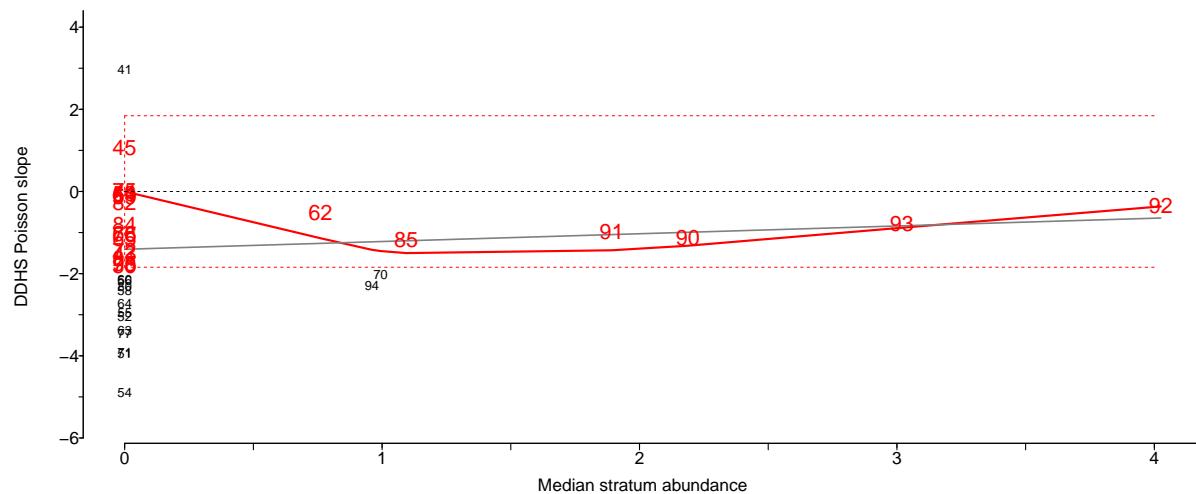


863



Freq	Depth	Temp	Sal
F5	31	1.0	31.00
F25	52	2.8	32.46
F50	69	5.1	33.22
F75	85	7.7	34.34
F95	116	10.0	35.03

Figure 7.20E. Catch distribution by depth, temperature and salinity of Ocean pout.



864

Figure 7.20F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Ocean pout.

865 **7.21 Thorny skate (Raie épineuse) - species code 201 (category LF)**

866 Scientific name: [Amblyraja radiata](#)

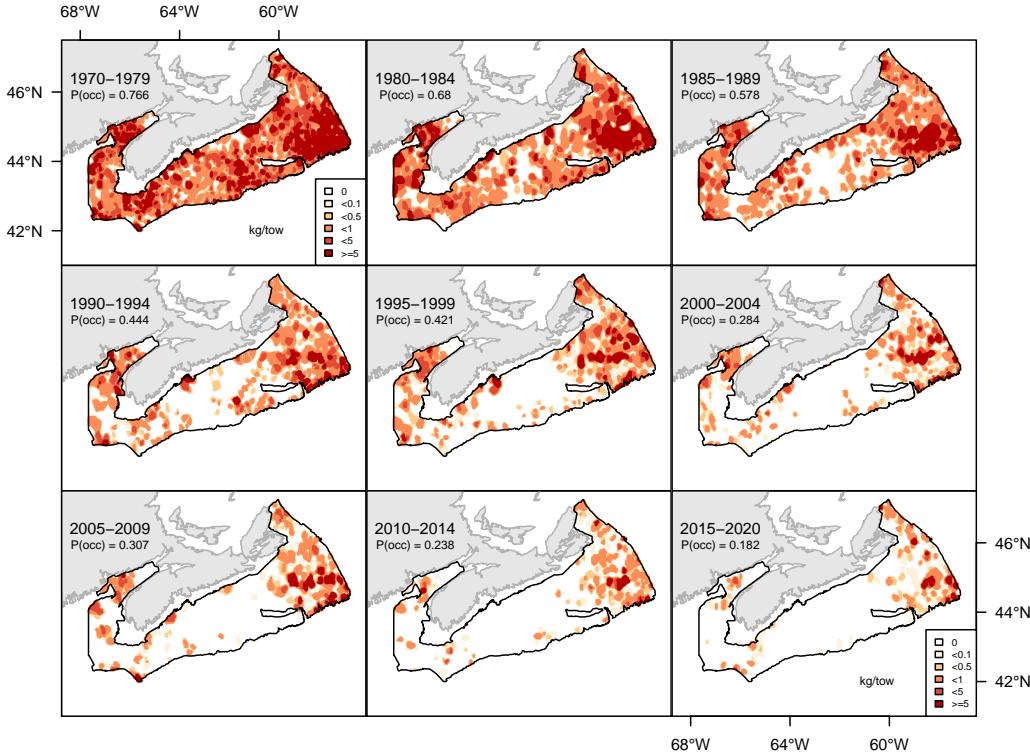


Figure 7.21A. Inverse distance weighted distribution of catch biomass (kg/tow) for Thorny skate.

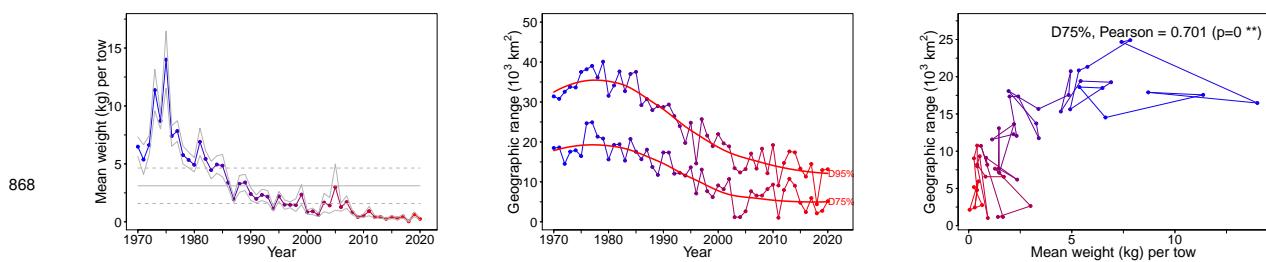


Figure 7.21B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Thorny skate.

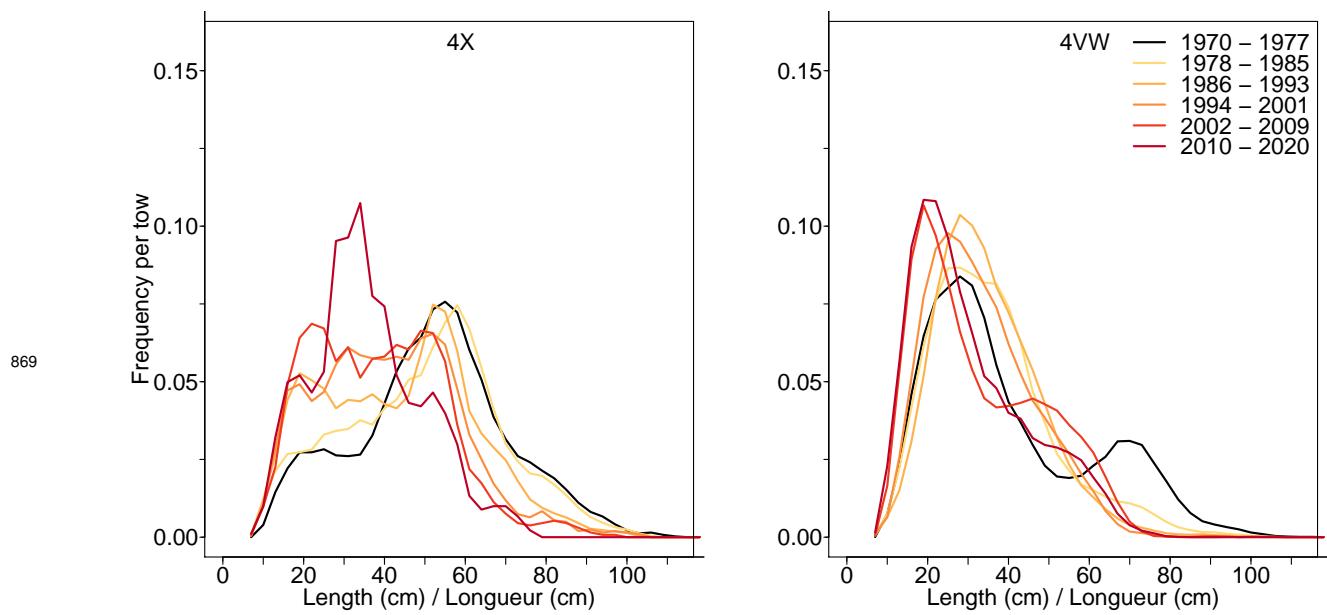


Figure 7.21C. Length frequency distribution in NAFO units 4X and 4VW for Thorny skate.

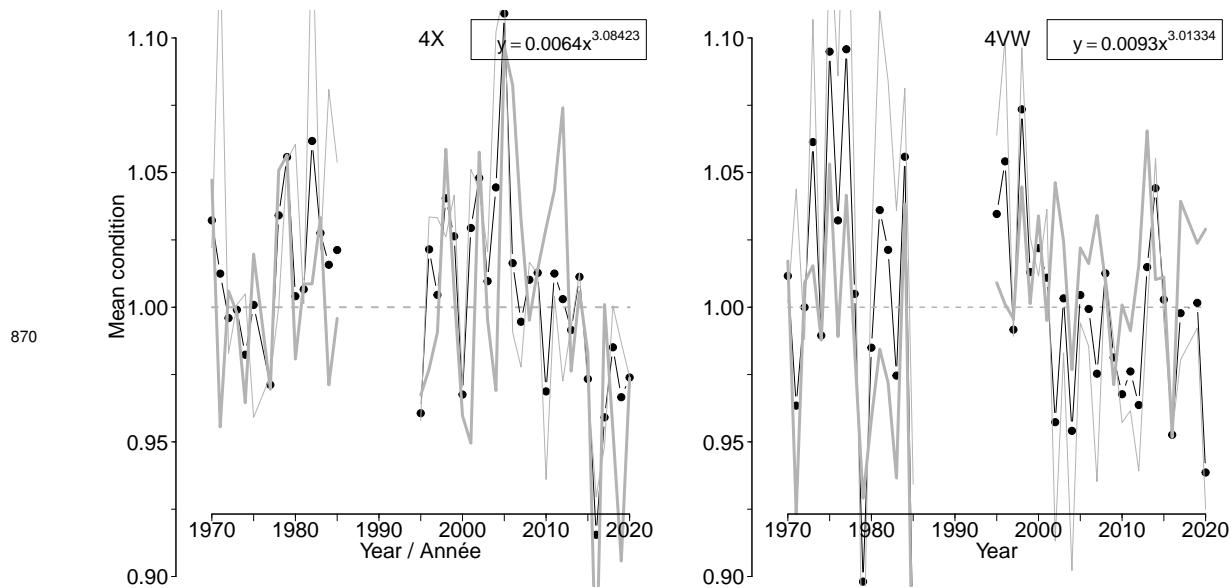
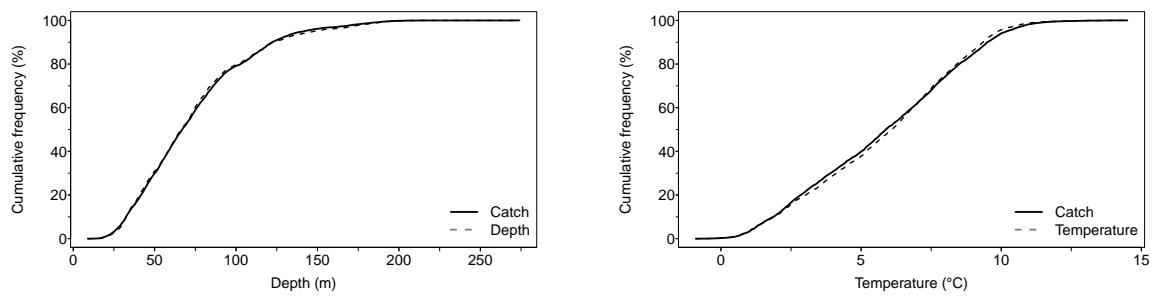
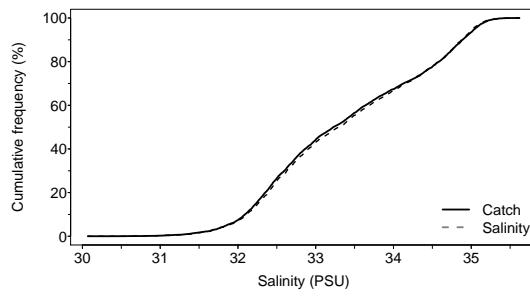


Figure 7.21D. Average fish condition in NAFO units 4X and 4VW for Thorny skate.



871



Freq	Depth	Temp	Sal
F5	29	1.3	31.00
F25	45	3.7	32.50
F50	67	6.2	33.30
F75	91	8.1	34.40
F95	148	9.9	35.03

Figure 7.21E. Catch distribution by depth, temperature and salinity of Thorny skate.

872

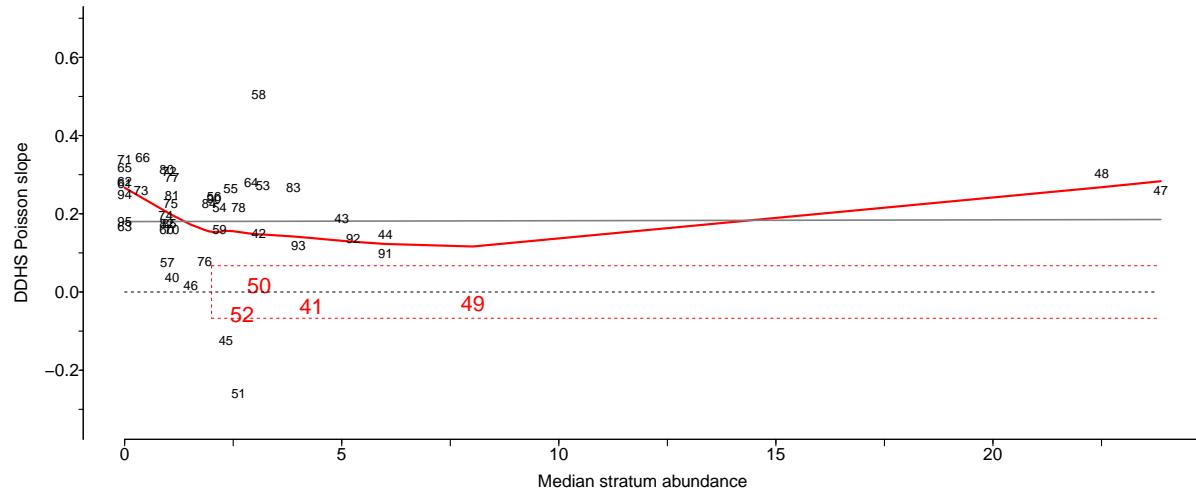


Figure 7.21F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Thorny skate.

873

7.22 Smooth skate (Raie lisse) - species code 202 (category LF)

874

Scientific name: [Malacoraja senta](#)

875

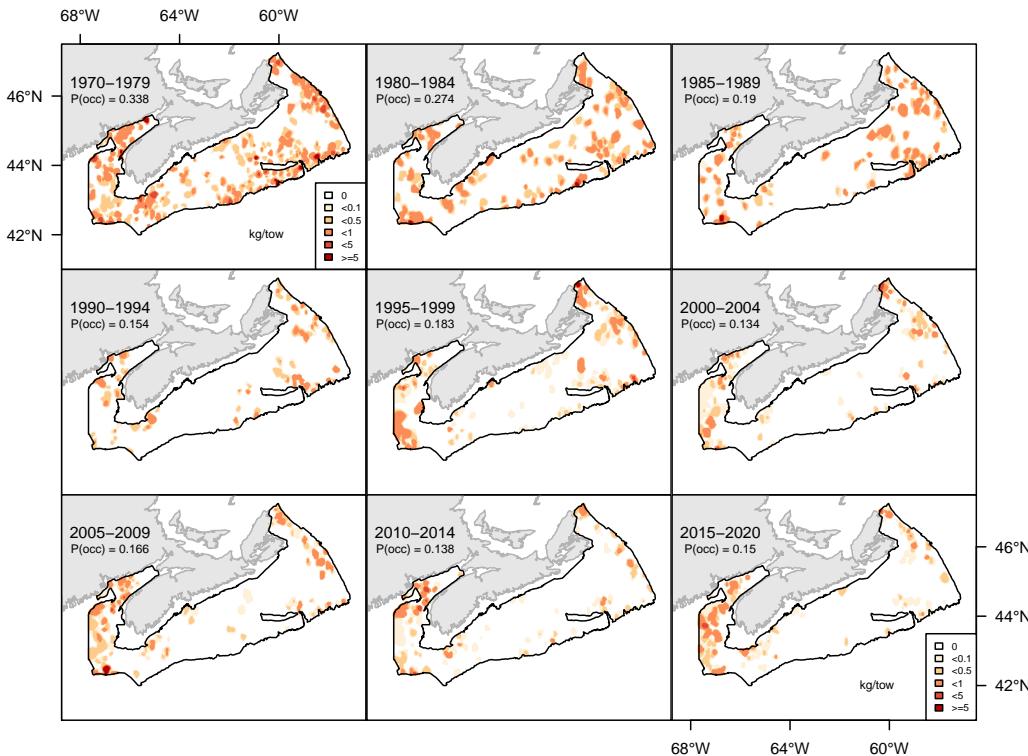


Figure 7.22A. Inverse distance weighted distribution of catch biomass (kg/tow) for Smooth skate.

876

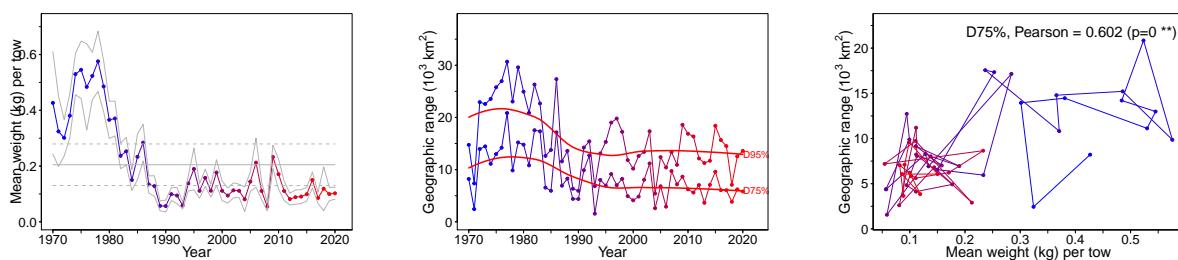


Figure 7.22B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Smooth skate.

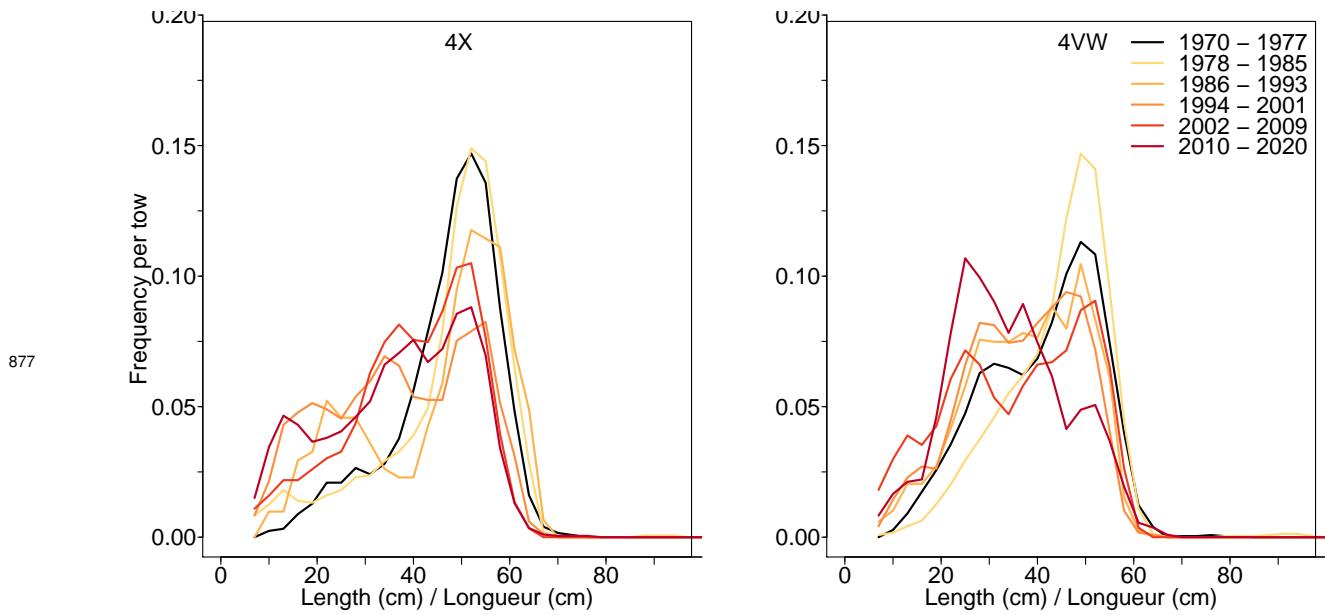


Figure 7.22C. Length frequency distribution in NAFO units 4X and 4VW for Smooth skate.

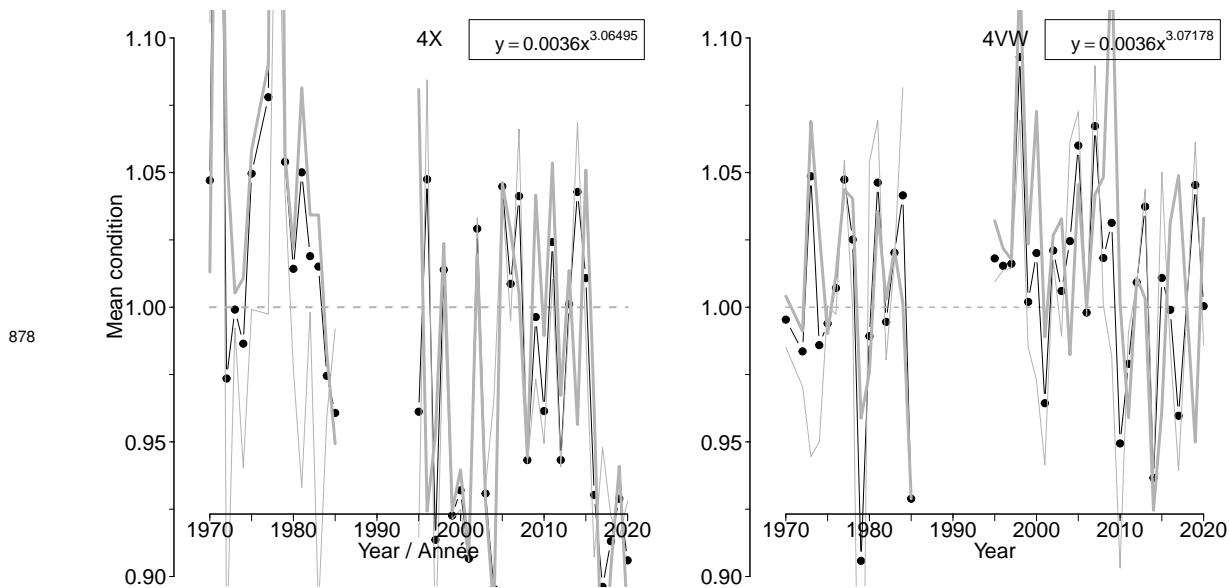
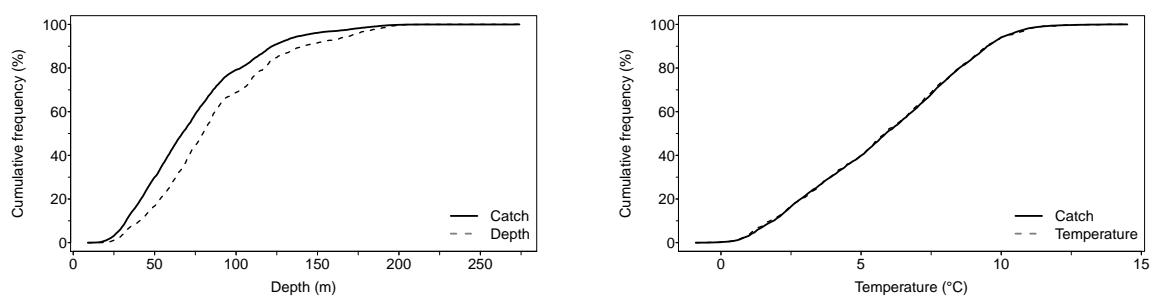
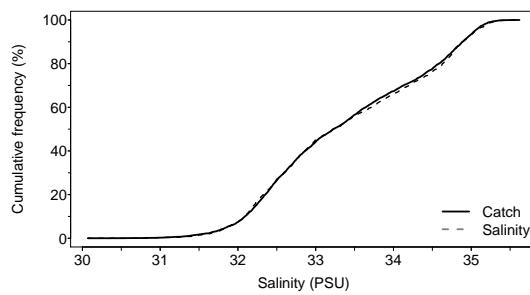


Figure 7.22D. Average fish condition in NAFO units 4X and 4VW for Smooth skate.



879



Freq	Depth	Temp	Sal
F5	33	1.2	31.00
F25	59	3.5	32.47
F50	80	5.9	33.23
F75	110	8.1	34.45
F95	171	10.0	35.06

Figure 7.22E. Catch distribution by depth, temperature and salinity of Smooth skate.

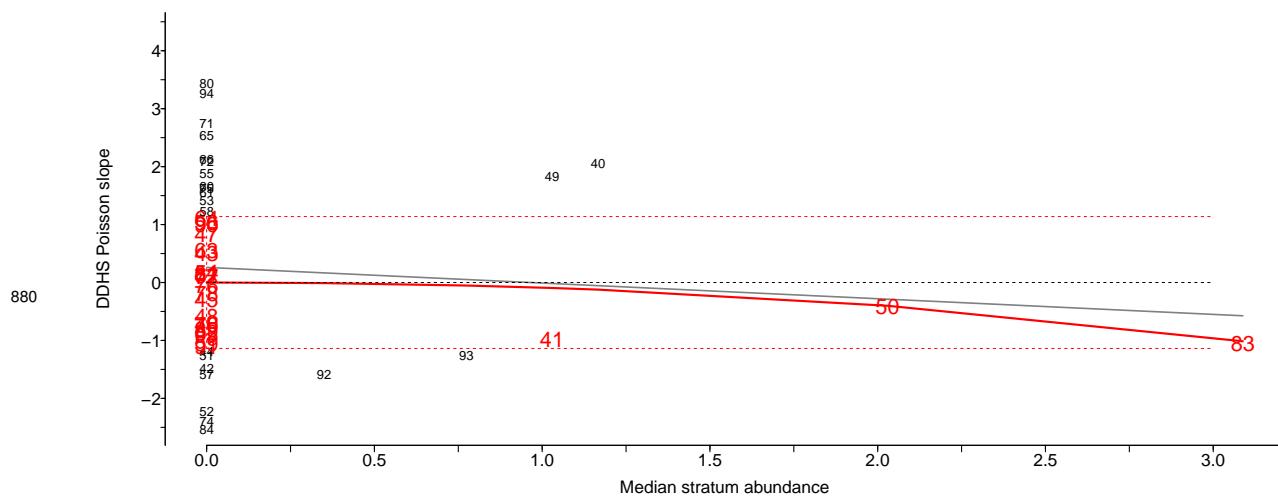


Figure 7.22F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Smooth skate.

881 **7.23 Winter skate (Raie tachetée) - species code 204 (category LF)**

882 Scientific name: [Leucoraja ocellata](#)

883

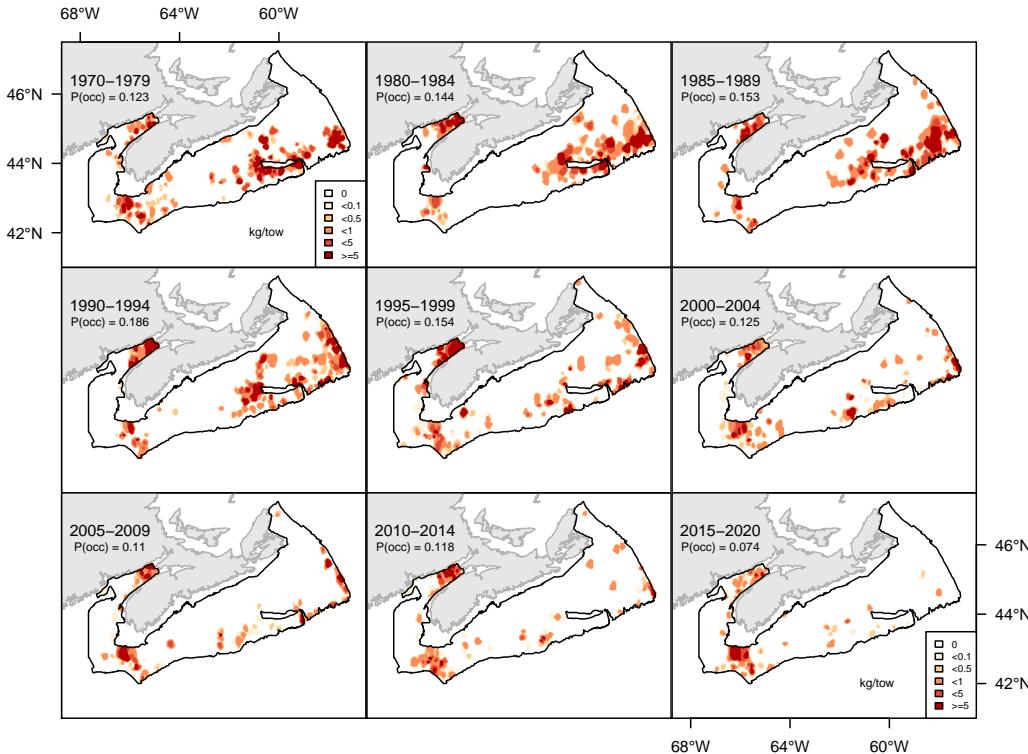


Figure 7.23A. Inverse distance weighted distribution of catch biomass (kg/tow) for Winter skate.

884

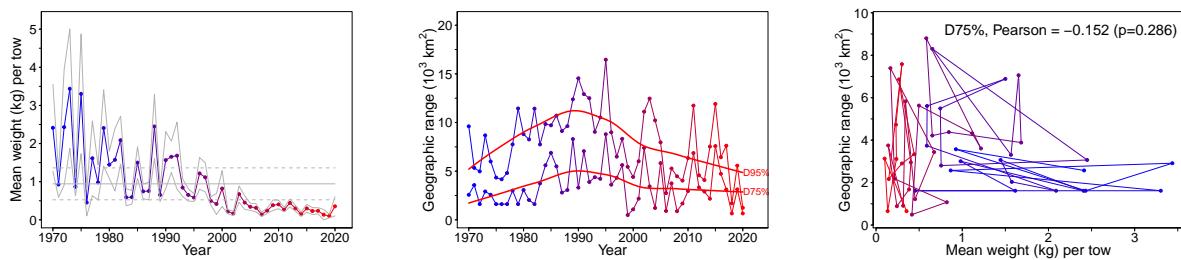


Figure 7.23B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Winter skate.

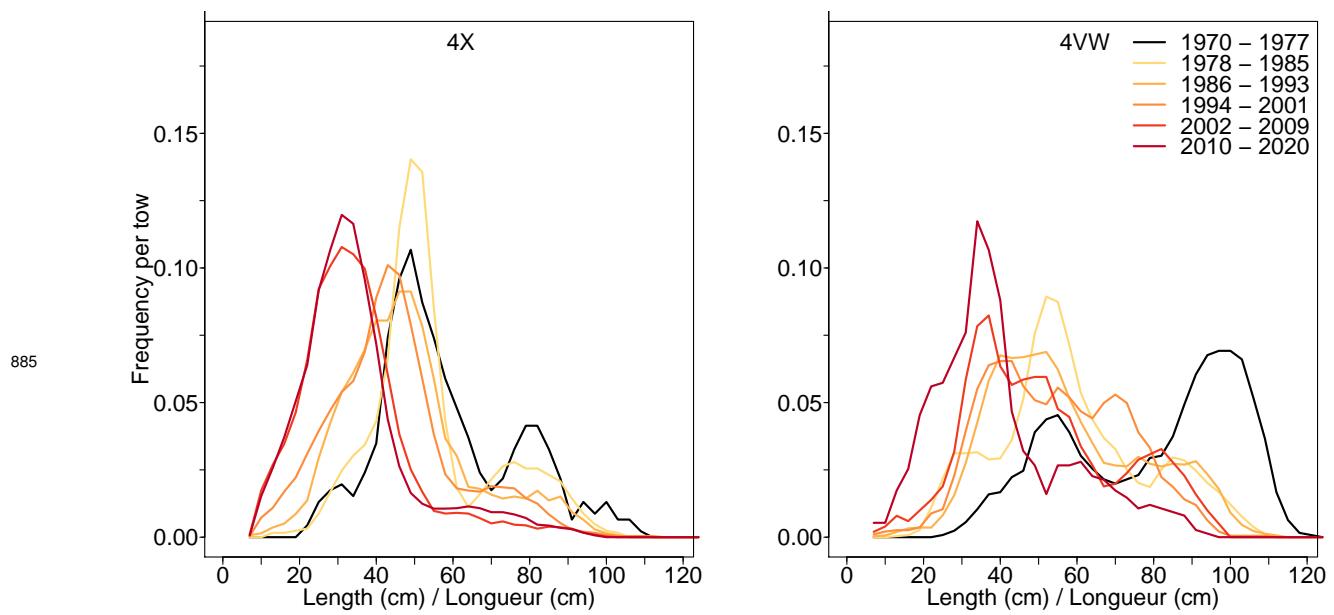


Figure 7.23C. Length frequency distribution in NAFO units 4X and 4VW for Winter skate.

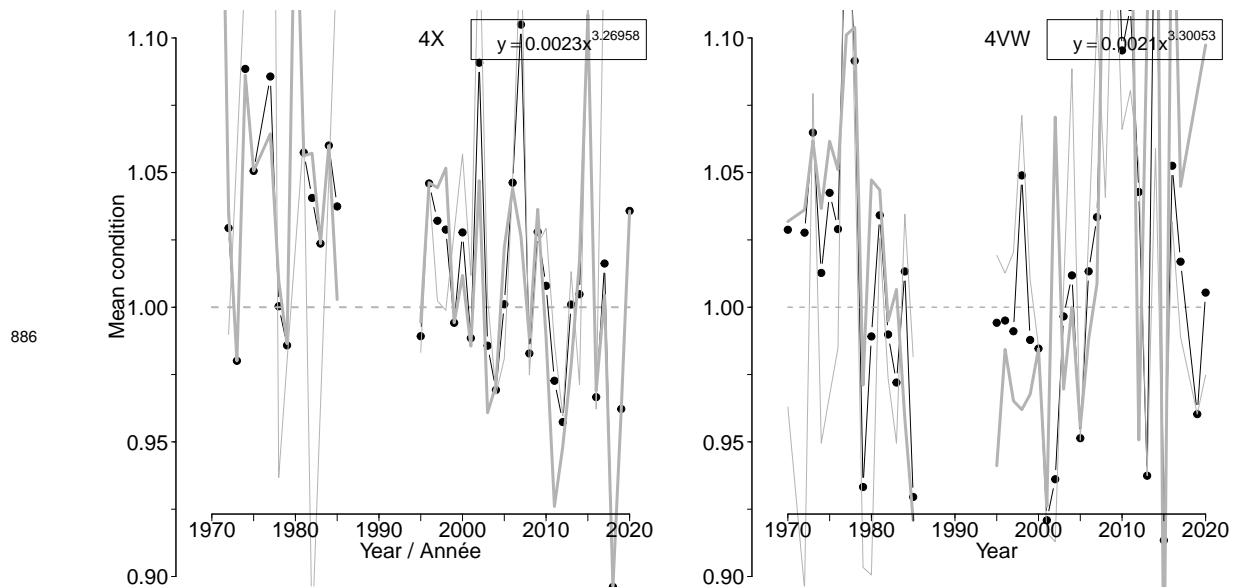
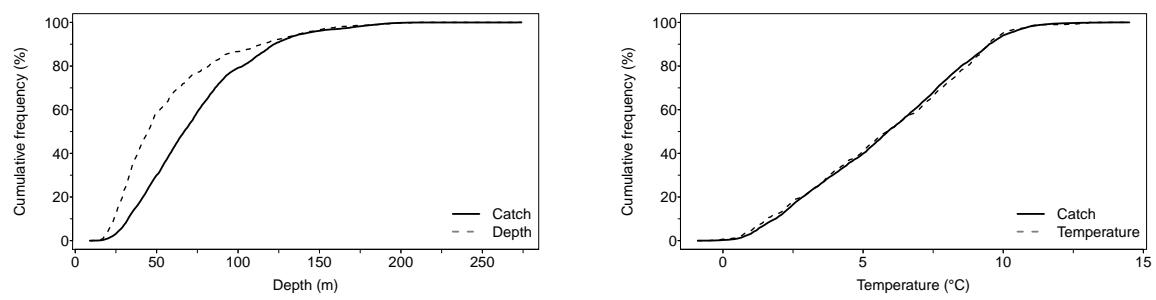
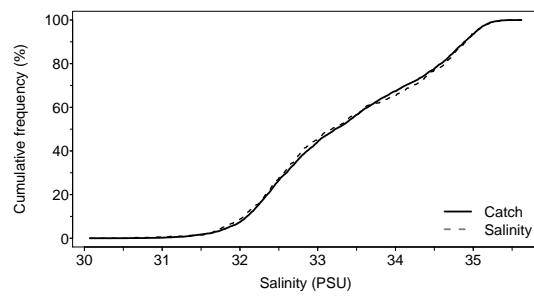


Figure 7.23D. Average fish condition in NAFO units 4X and 4VW for Winter skate.



887



Freq	Depth	Temp	Sal
F5	21	1.1	31.00
F25	32	3.5	32.44
F50	45	5.9	33.19
F75	71	8.3	34.42
F95	140	10.0	35.03

Figure 7.23E. Catch distribution by depth, temperature and salinity of Winter skate.

888

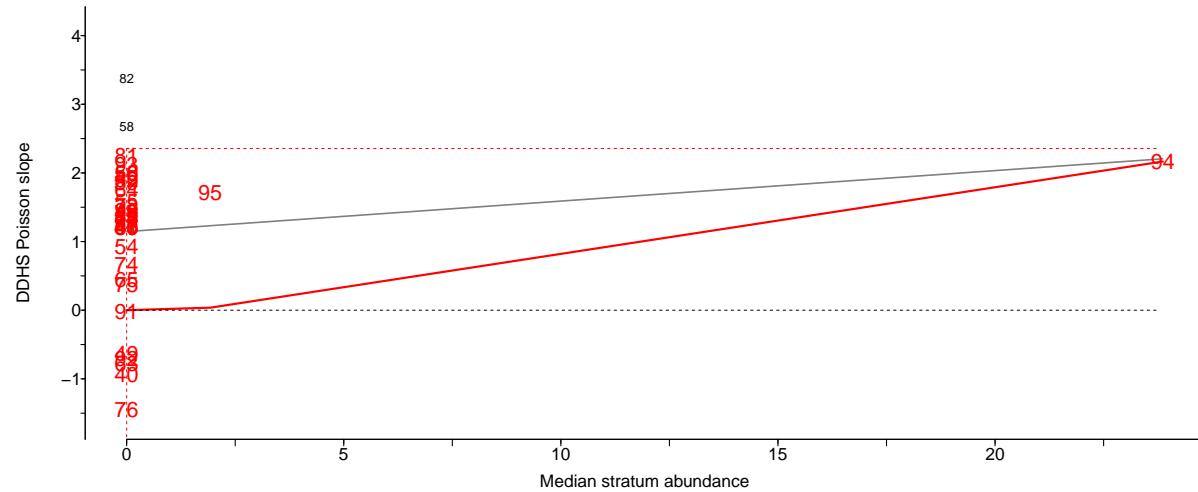


Figure 7.23F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Winter skate.

889 **7.24 Picked dogfish (Aiguillat commun) - species code 220 (category LF)**

890 Scientific name: [Squalus acanthias](#)

891

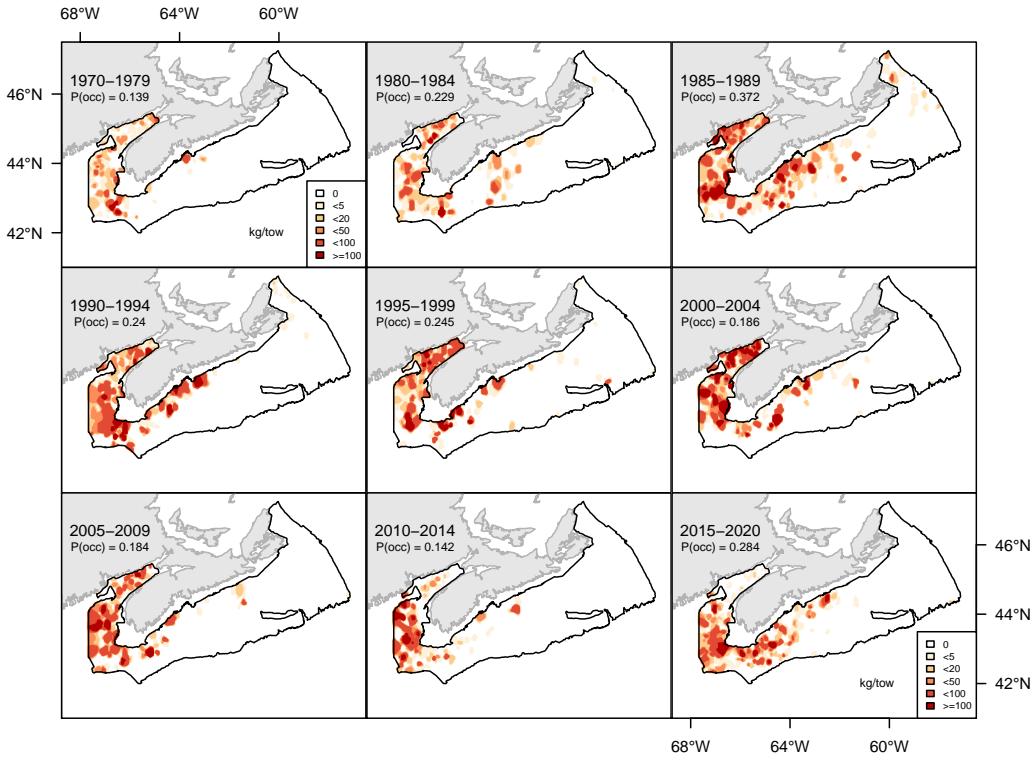


Figure 7.24A. Inverse distance weighted distribution of catch biomass (kg/tow) for Picked dogfish.

892

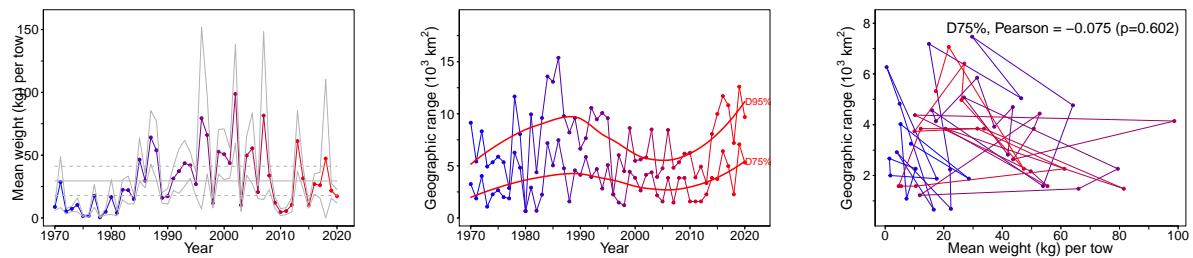


Figure 7.24B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Picked dogfish.

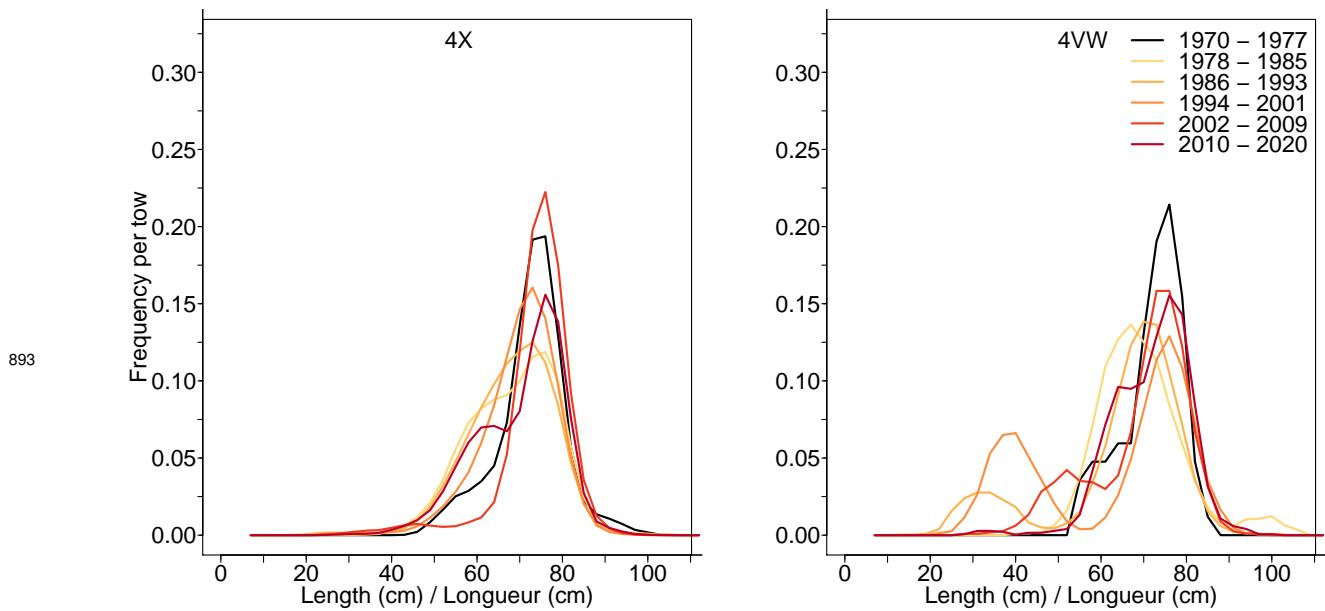


Figure 7.24C. Length frequency distribution in NAFO units 4X and 4VW for Picked dogfish.

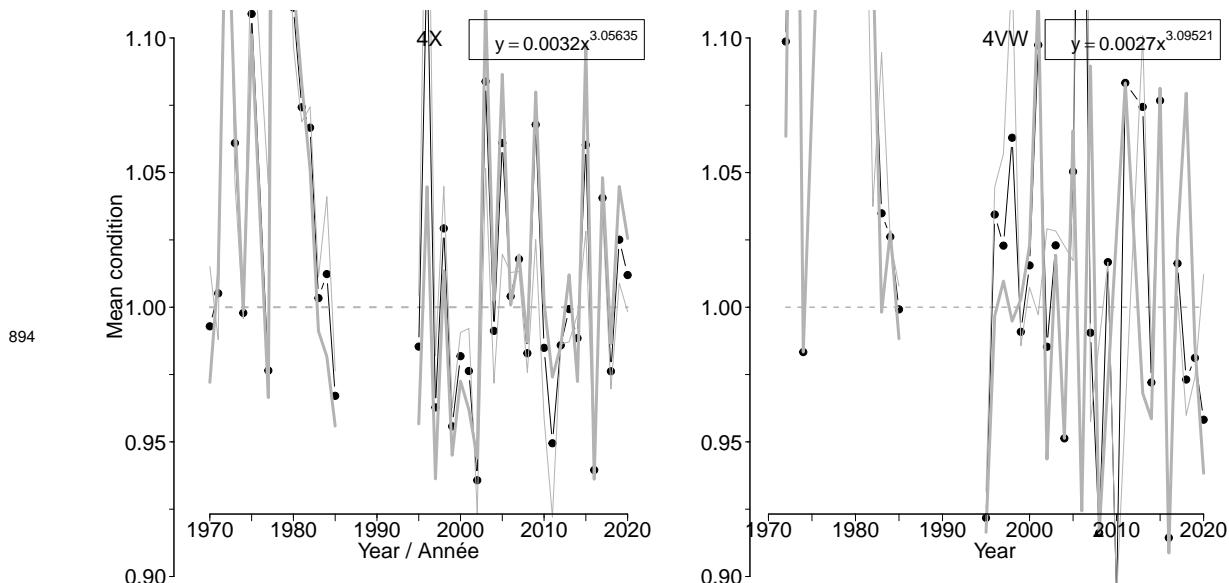
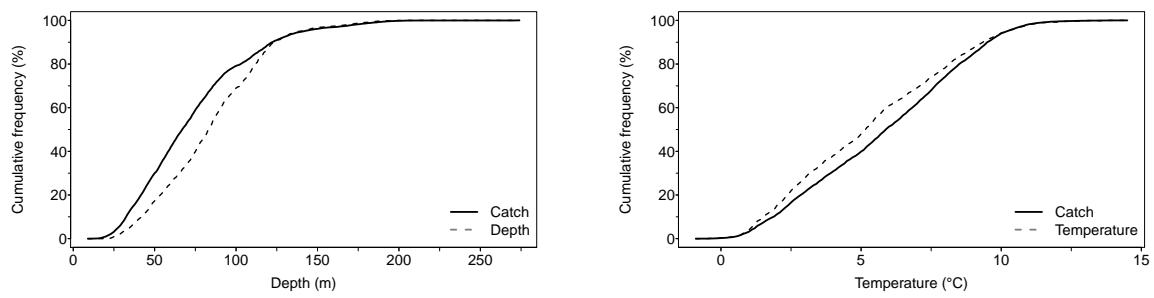
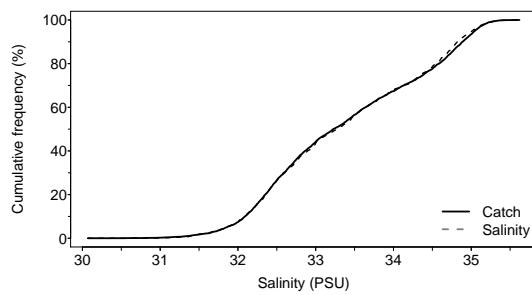


Figure 7.24D. Average fish condition in NAFO units 4X and 4VW for Picked dogfish.



895



Freq	Depth	Temp	Sal
F5	35	1.1	31.00
F25	60	2.8	32.47
F50	83	5.2	33.28
F75	108	7.7	34.37
F95	139	10.0	35.02

Figure 7.24E. Catch distribution by depth, temperature and salinity of Picked dogfish.

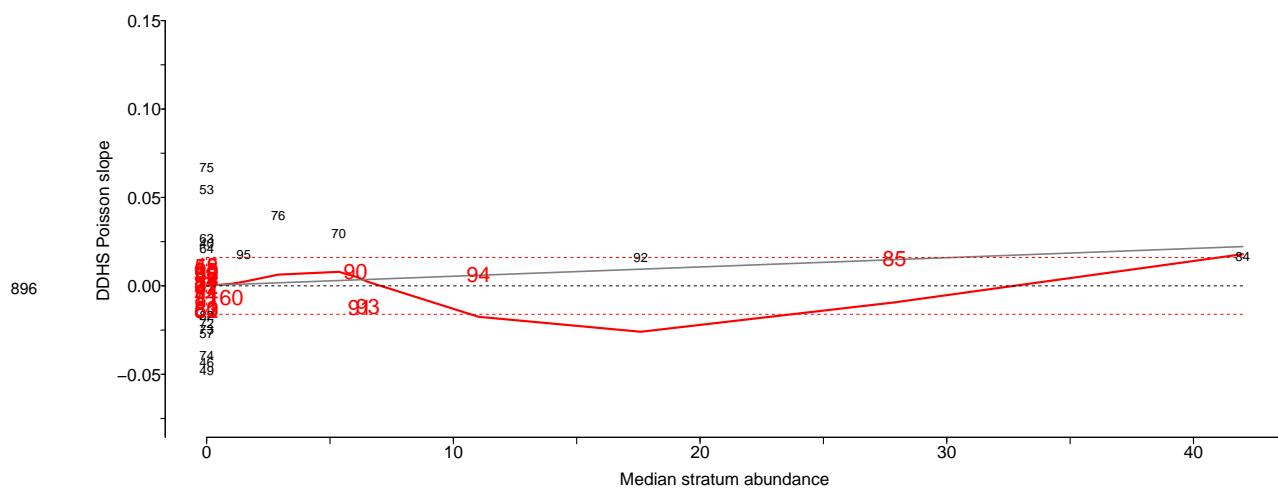


Figure 7.24F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Picked dogfish.

897 **7.25 Northern shortfin squid (*Encornet rouge nordique*) - species code 4511 (category
898 LF)**

899 Scientific name: [Illex illecebrosus](#)

900

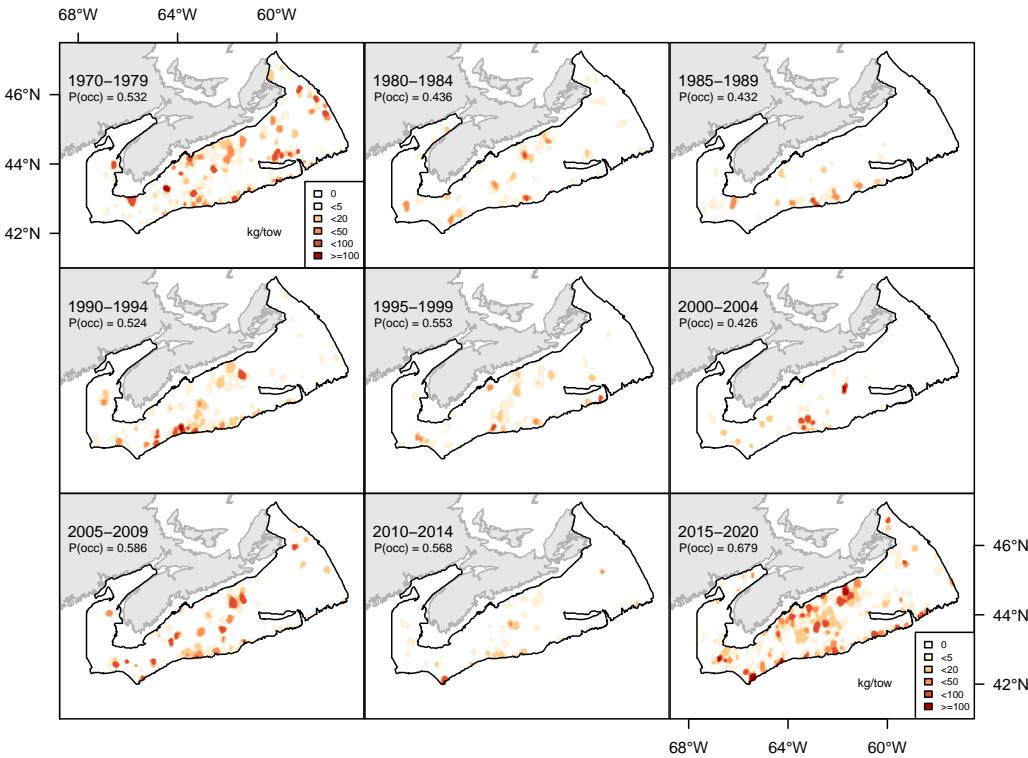


Figure 7.25A. Inverse distance weighted distribution of catch biomass (kg/tow) for Northern shortfin squid.

901

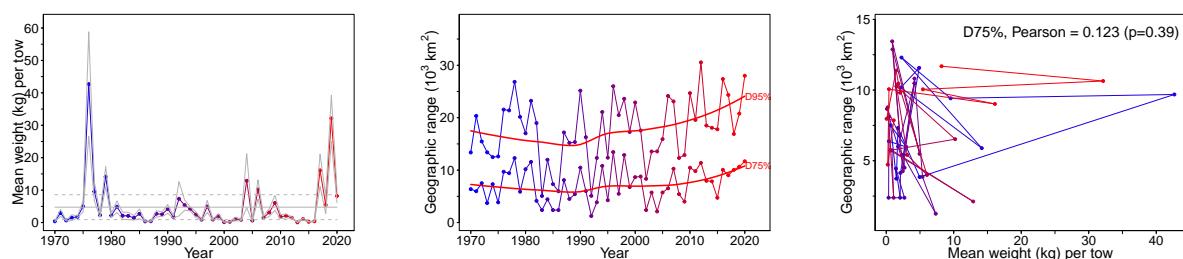


Figure 7.25B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Northern shortfin squid.

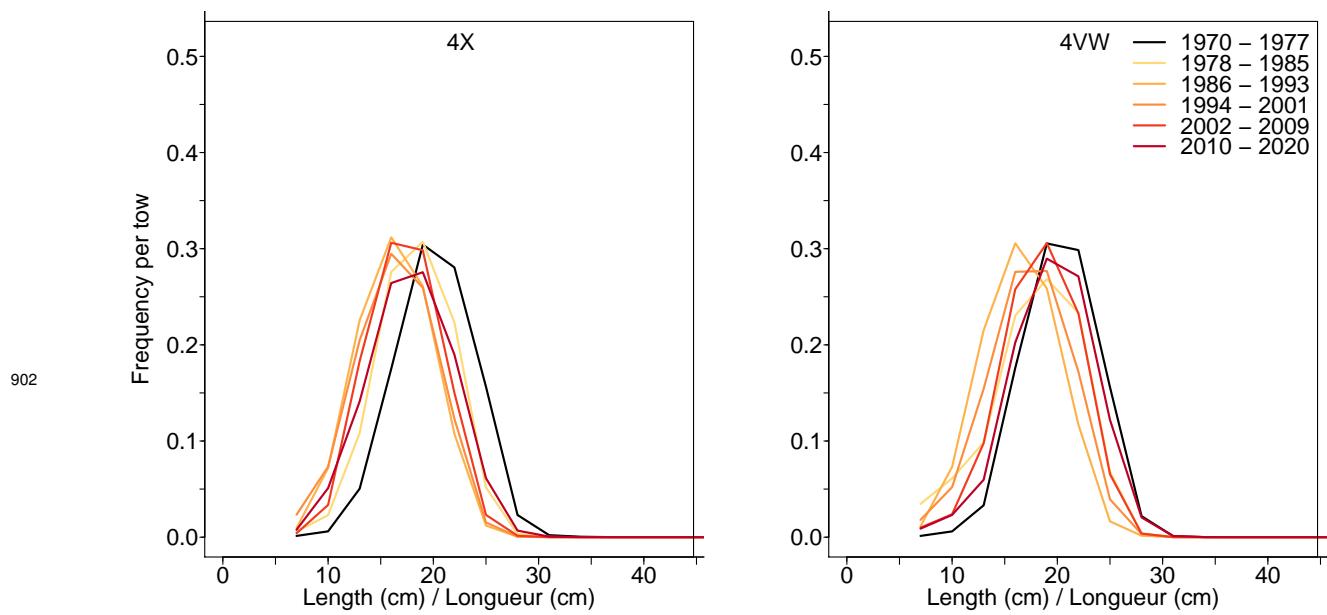


Figure 7.25C. Length frequency distribution in NAFO units 4X and 4VW for Northern shortfin squid.

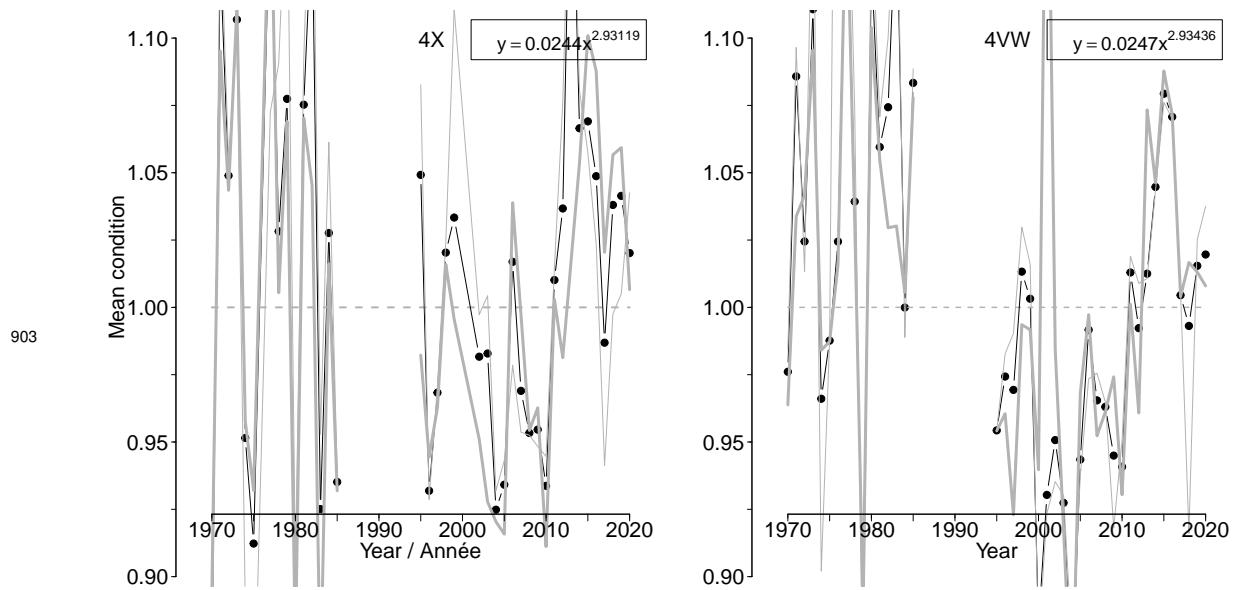
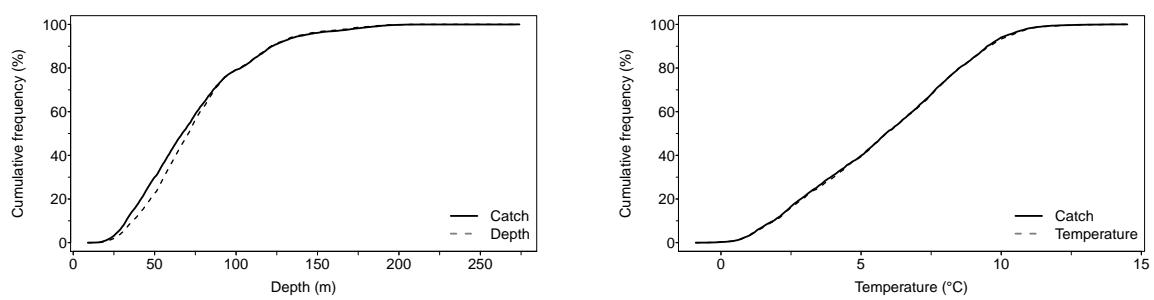
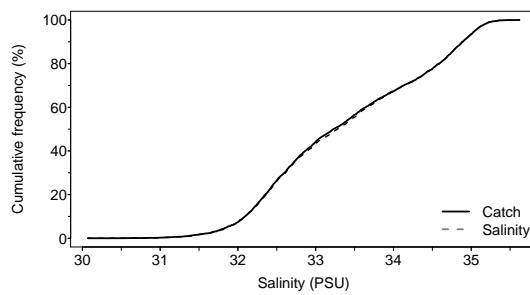


Figure 7.25D. Average fish condition in NAFO units 4X and 4VW for Northern shortfin squid.



904



Freq	Depth	Temp	Sal
F5	31	1.3	31.00
F25	53	3.5	32.48
F50	71	5.9	33.28
F75	93	8.1	34.39
F95	139	10.0	35.05

Figure 7.25E. Catch distribution by depth, temperature and salinity of Northern shortfin squid.

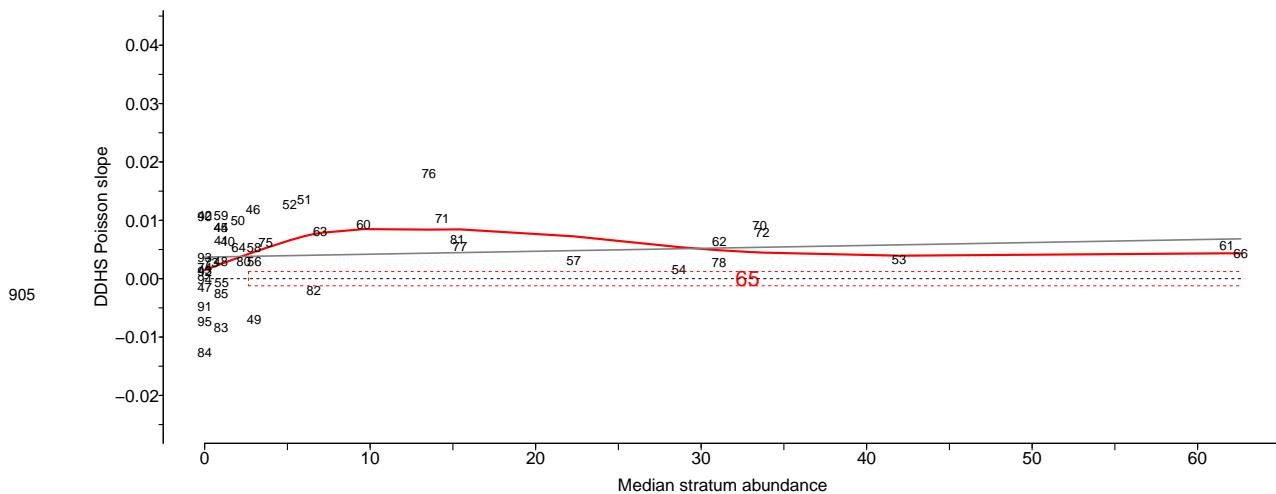


Figure 7.25F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Northern shortfin squid.

906

7.26 Atlantic hagfish (*Myxine du nord*) - species code 241 (category LI)

907

Scientific name: [Myxine glutinosa](#)

908

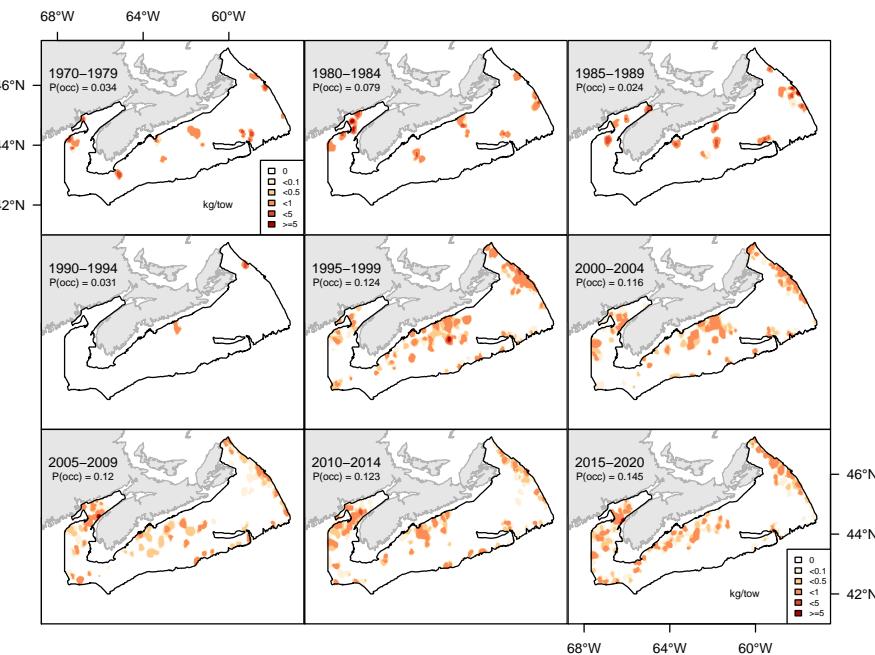


Figure 7.26A. Inverse distance weighted distribution of catch biomass (kg/tow) for Atlantic hagfish.

909

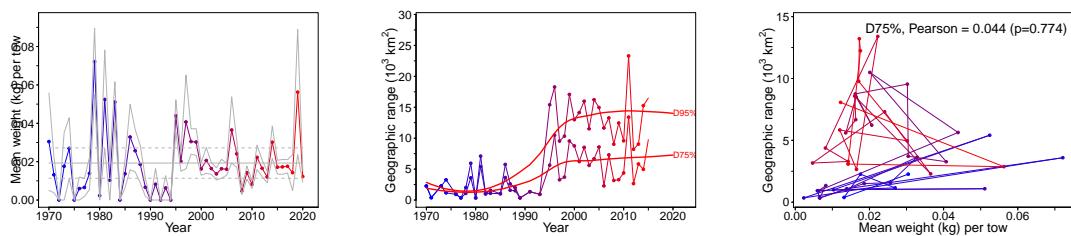


Figure 7.26B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Atlantic hagfish.

910

7.27 Cusk (Brosme) - species code 15 (category LI)

911

Scientific name: [Brosme brosme](#)

912

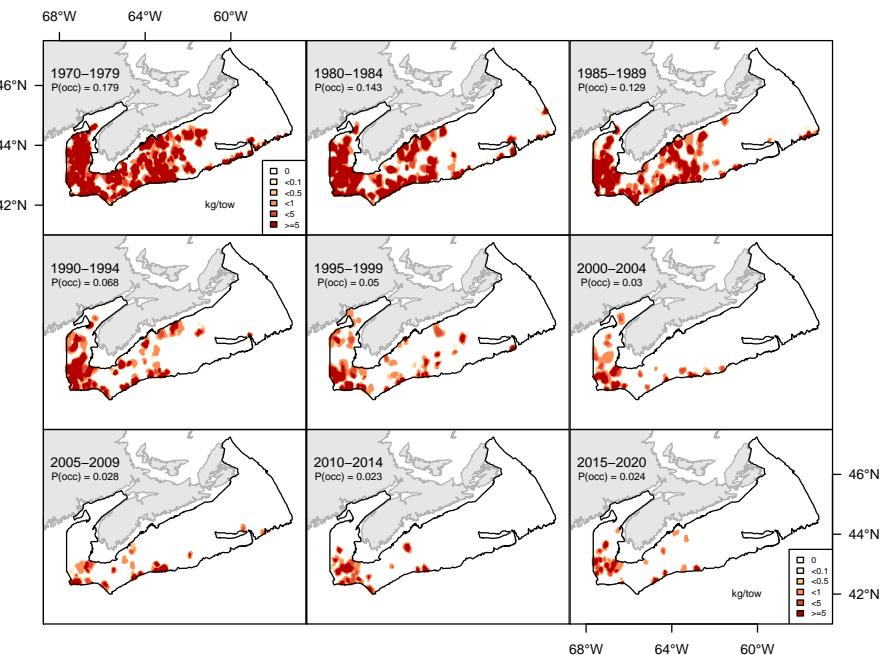


Figure 7.27A. Inverse distance weighted distribution of catch biomass (kg/tow) for Cusk.

913

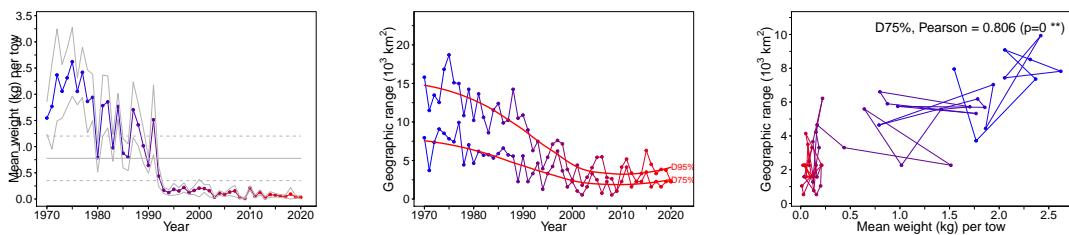


Figure 7.27B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Cusk.

914

7.28 Greenland halibut (Flétan noir) - species code 31 (category LI)

915

Scientific name: [Reinhardtius hippoglossoides](#)

916

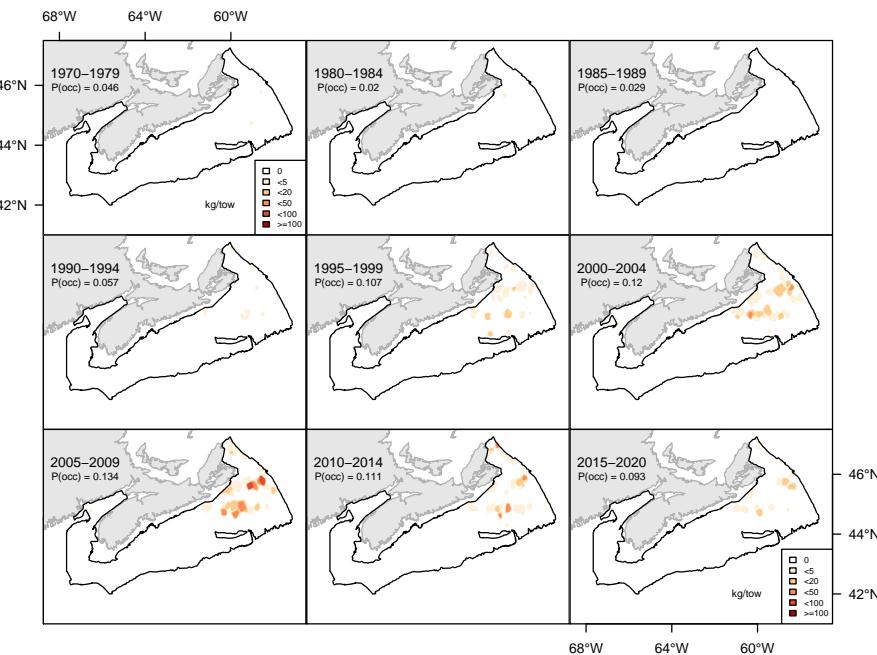


Figure 7.28A. Inverse distance weighted distribution of catch biomass (kg/tow) for Greenland halibut.

917

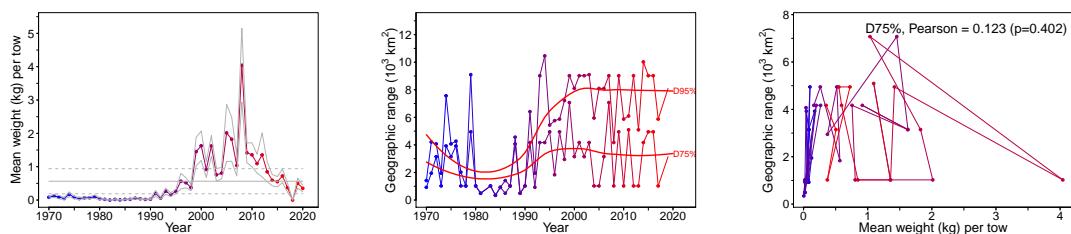


Figure 7.28B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Greenland halibut.

918

7.29 Gulf Stream flounder (Plie du Gulf Stream) - species code 44 (category LI)

919

Scientific name: [Citharichthys arctifrons](#)

920

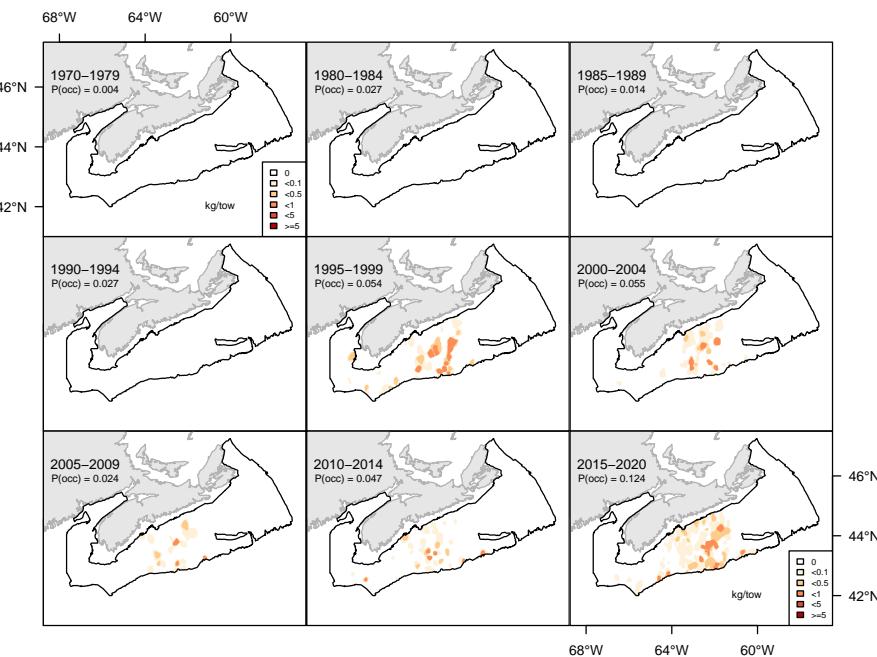


Figure 7.29A. Inverse distance weighted distribution of catch biomass (kg/tow) for Gulf Stream flounder.

921

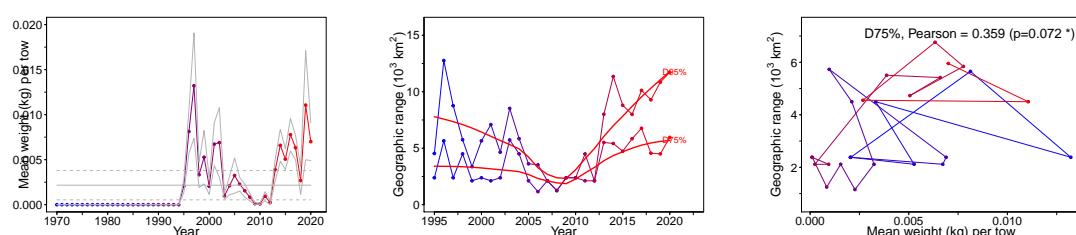


Figure 7.29B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Gulf Stream flounder.

922

7.30 American shad (*Alose savoureuse*) - species code 61 (category LI)

923

Scientific name: [Alosa sapidissima](#)

924

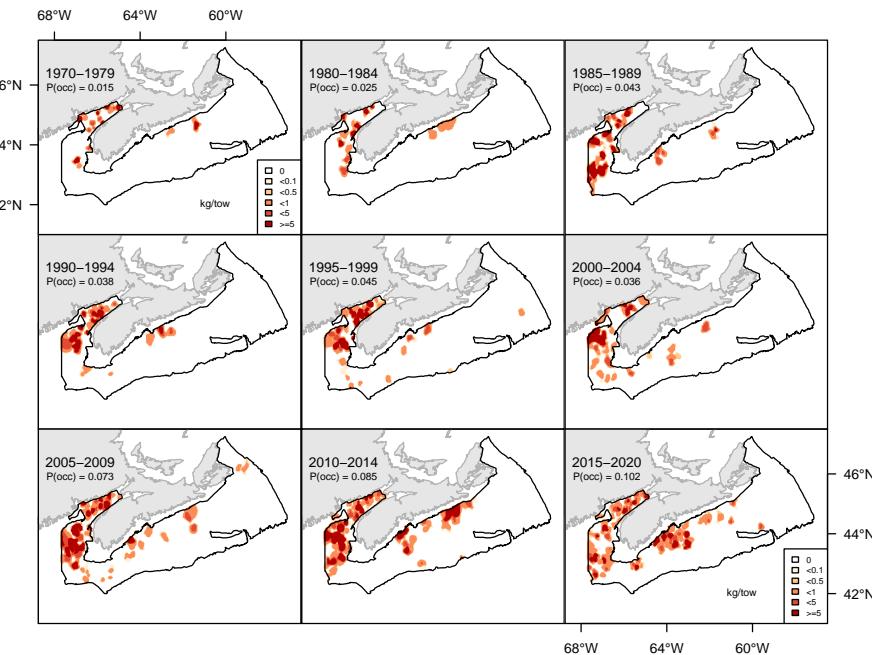


Figure 7.30A. Inverse distance weighted distribution of catch biomass (kg/tow) for American shad.

925

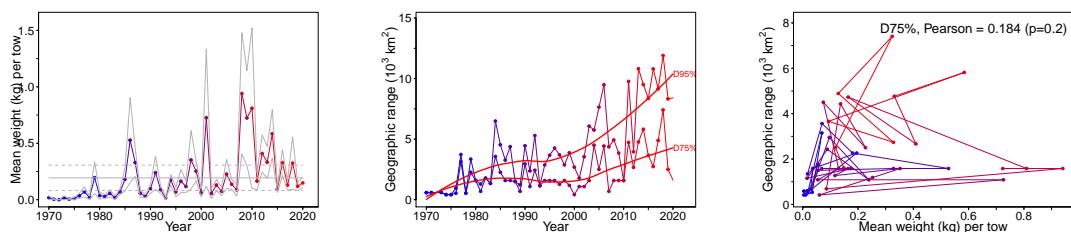


Figure 7.30B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of American shad.

926

7.31 Alewife (Gaspareau) - species code 62 (category LI)

927

Scientific name: *Alosa pseudoharengus*

928

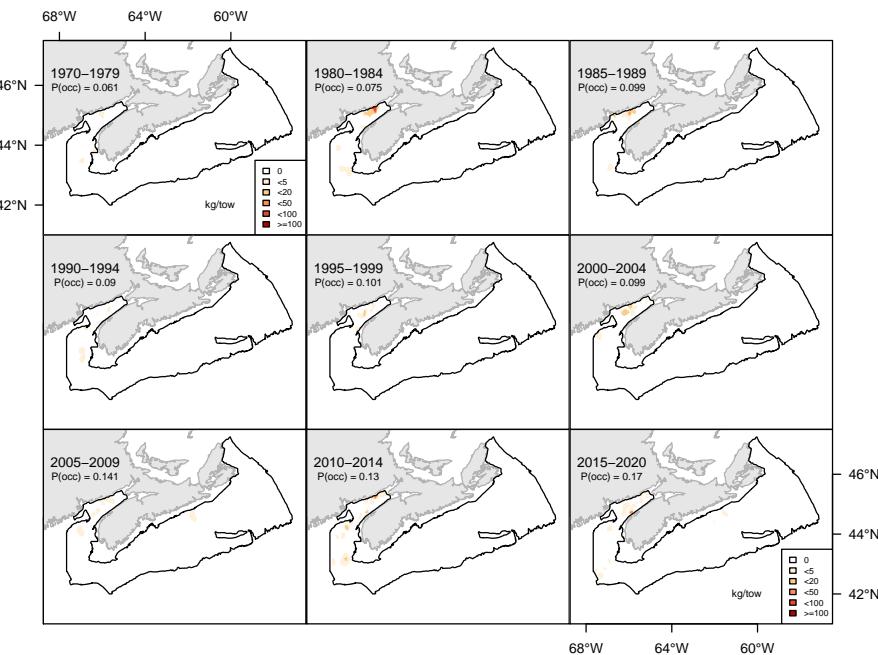


Figure 7.31A. Inverse distance weighted distribution of catch biomass (kg/tow) for Alewife.

929

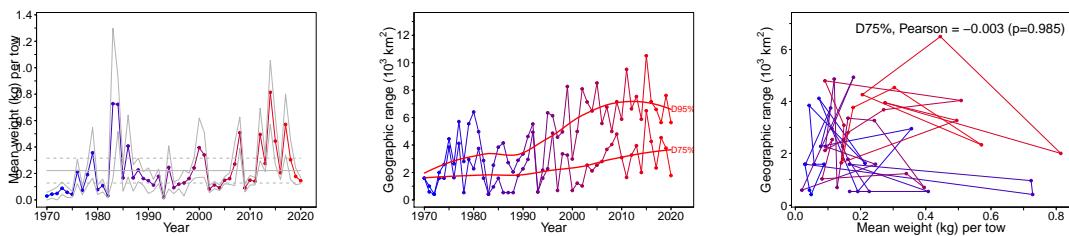


Figure 7.31B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Alewife.

930

7.32 Capelin (Capelan) - species code 64 (category LI)

931

Scientific name: [Mallotus villosus](#)

932

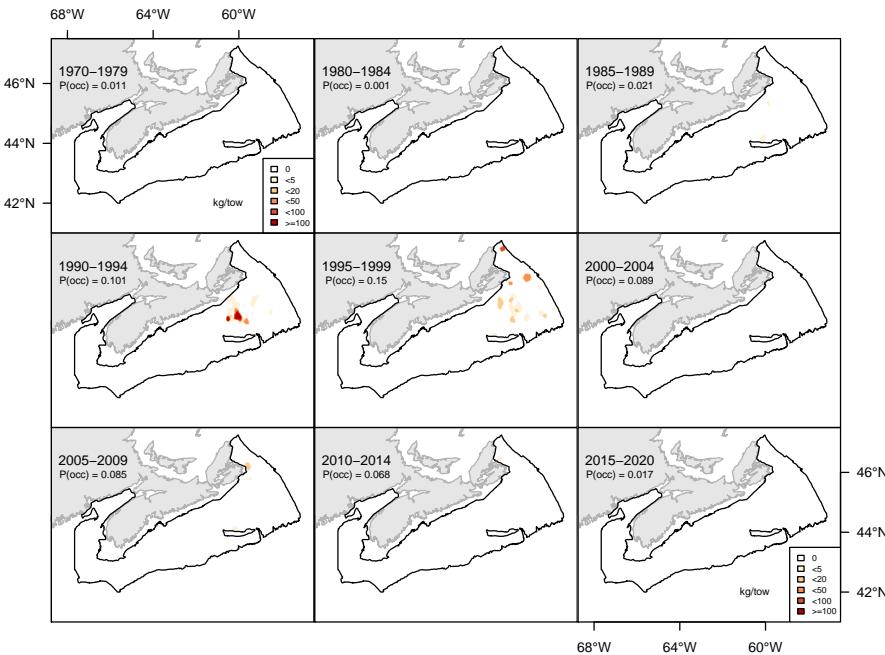


Figure 7.32A. Inverse distance weighted distribution of catch biomass (kg/tow) for Capelin.

933

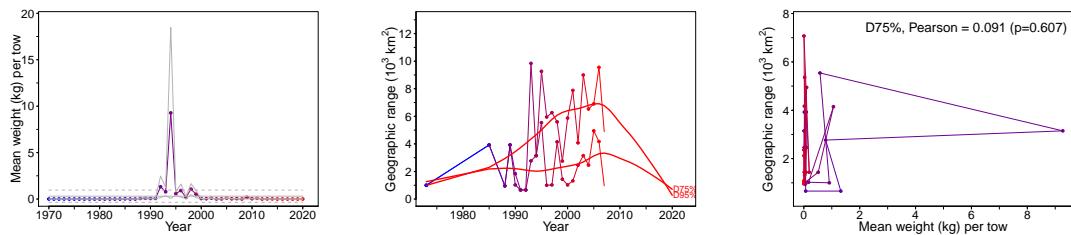


Figure 7.32B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Capelin.

934

7.33 Atlantic mackerel (*Maquereau commun*) - species code 70 (category LI)

935

Scientific name: *Scomber scombrus*

936

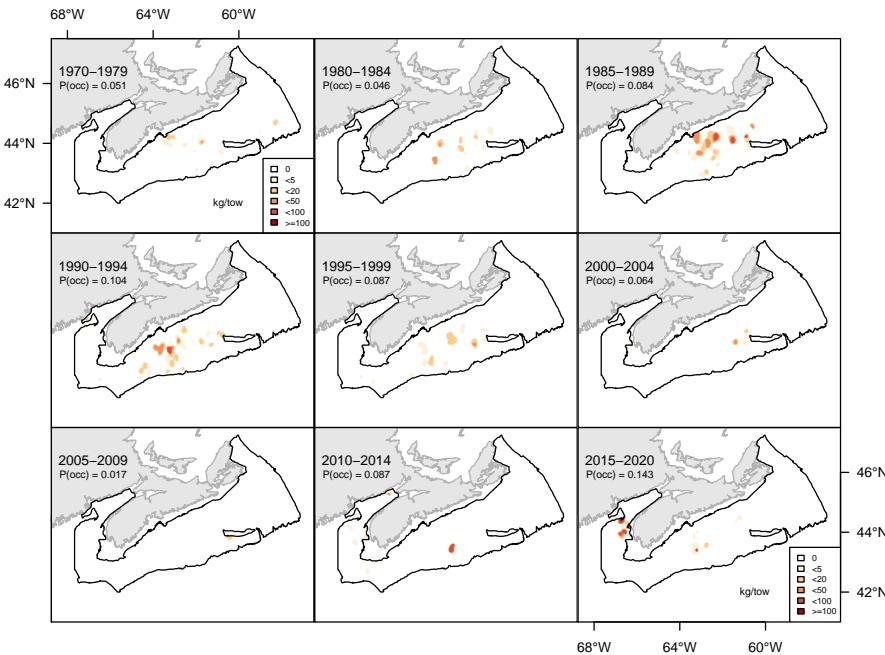


Figure 7.33A. Inverse distance weighted distribution of catch biomass (kg/tow) for Atlantic mackerel.

937

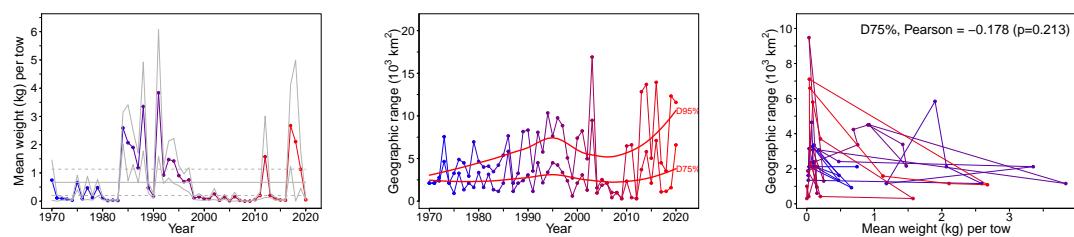


Figure 7.33B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Atlantic mackerel.

938

7.34 Longfin hake (Merluche à longues nageoires) - species code 112 (category LI)

939

Scientific name: [Phycis chesteri](#)

940

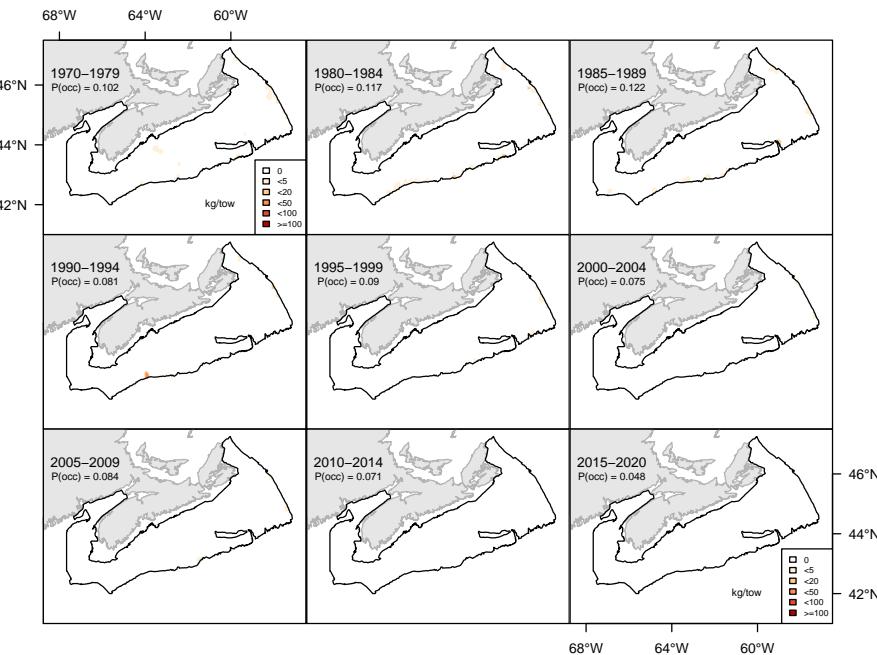


Figure 7.34A. Inverse distance weighted distribution of catch biomass (kg/tow) for Longfin hake.

941

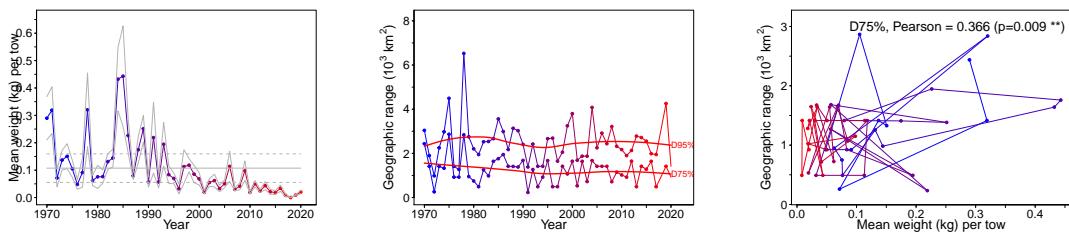


Figure 7.34B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Longfin hake.

942

7.35 Fourbeard rockling (Motelle à quatre barbillons) - species code 114 (category LI)

943

Scientific name: [Enchelyopus cimbrius](#)

944

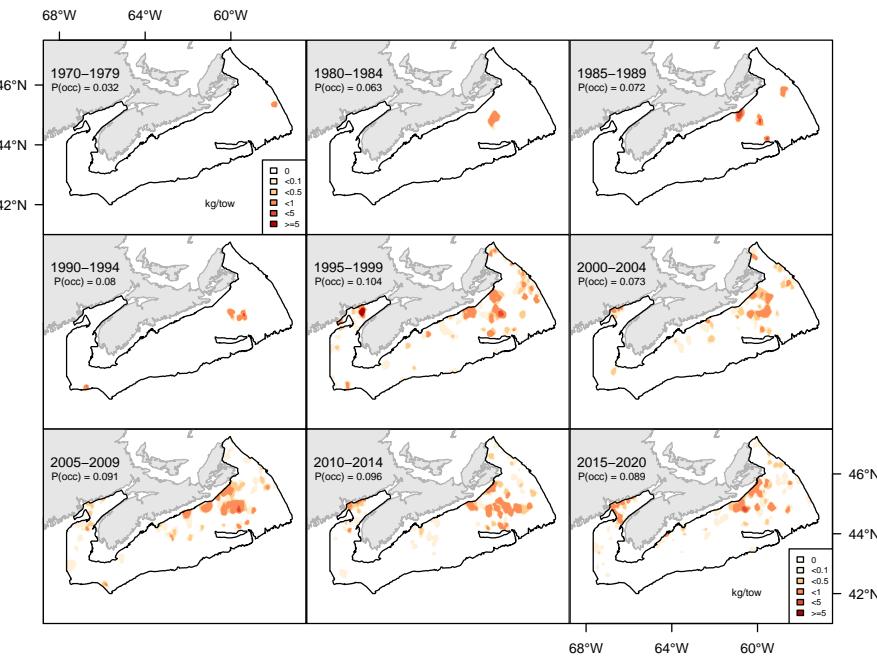


Figure 7.35A. Inverse distance weighted distribution of catch biomass (kg/tow) for Fourbeard rockling.

945

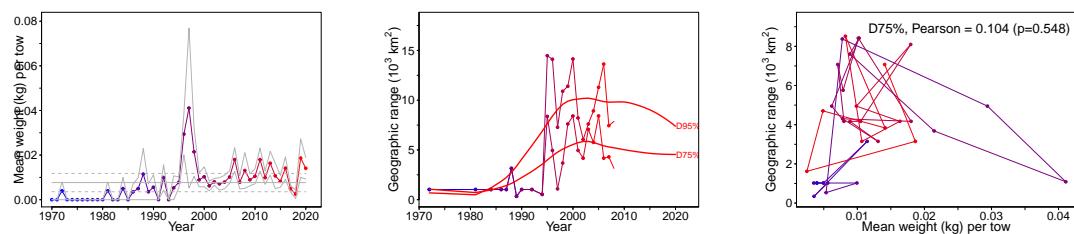


Figure 7.35B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Fourbeard rockling.

946

7.36 Blackbelly rosefish (Sébaste chèvre) - species code 123 (category LI)

947

Scientific name: [Helicolenus dactylopterus](#)

948

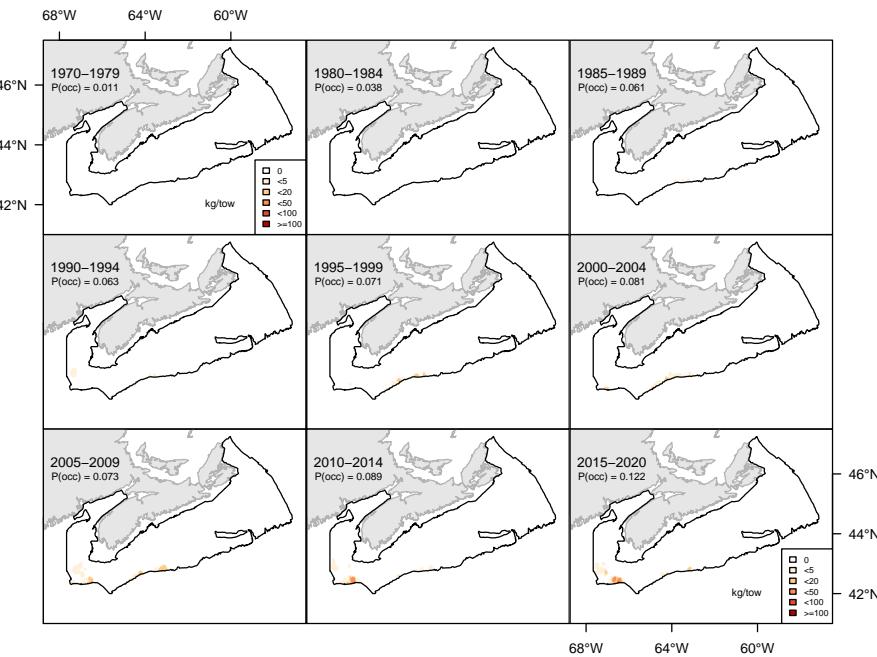


Figure 7.36A. Inverse distance weighted distribution of catch biomass (kg/tow) for Blackbelly rosefish.

949

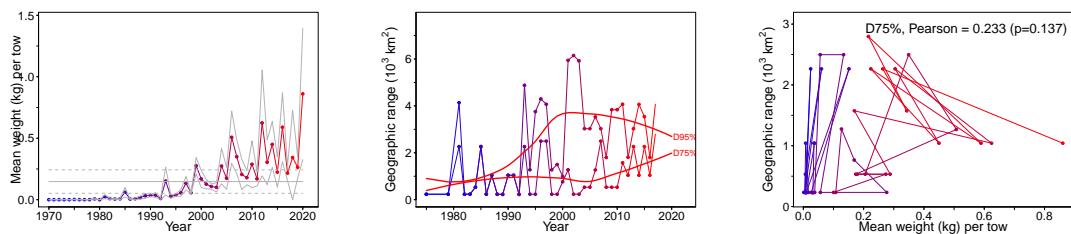


Figure 7.36B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Blackbelly rosefish.

950

7.37 Greater argentine (Grande argentine) - species code 160 (category LI)

951

Scientific name: [Argentina silus](#)

952

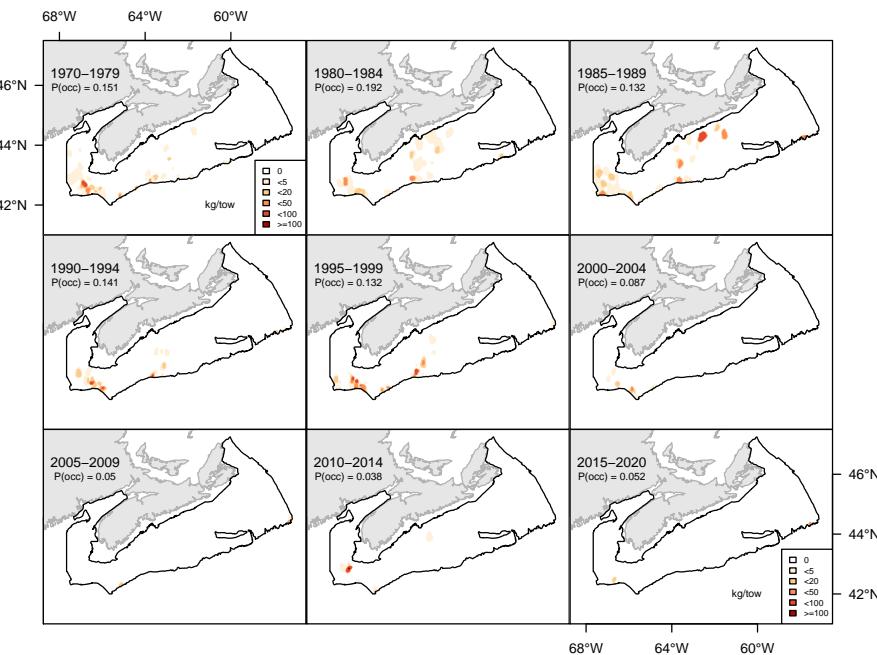


Figure 7.37A. Inverse distance weighted distribution of catch biomass (kg/tow) for Greater argentine.

953

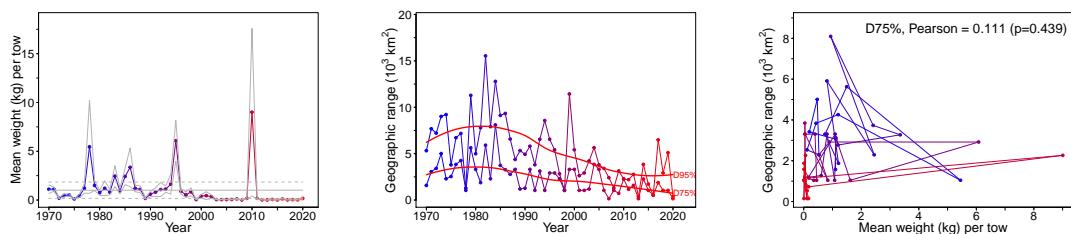


Figure 7.37B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Greater argentine.

954

7.38 Arctic hookear sculpin (*Hameçon neigeux*) - species code 306 (category LI)

955

Scientific name: [Artediellus uncinatus](#)

956

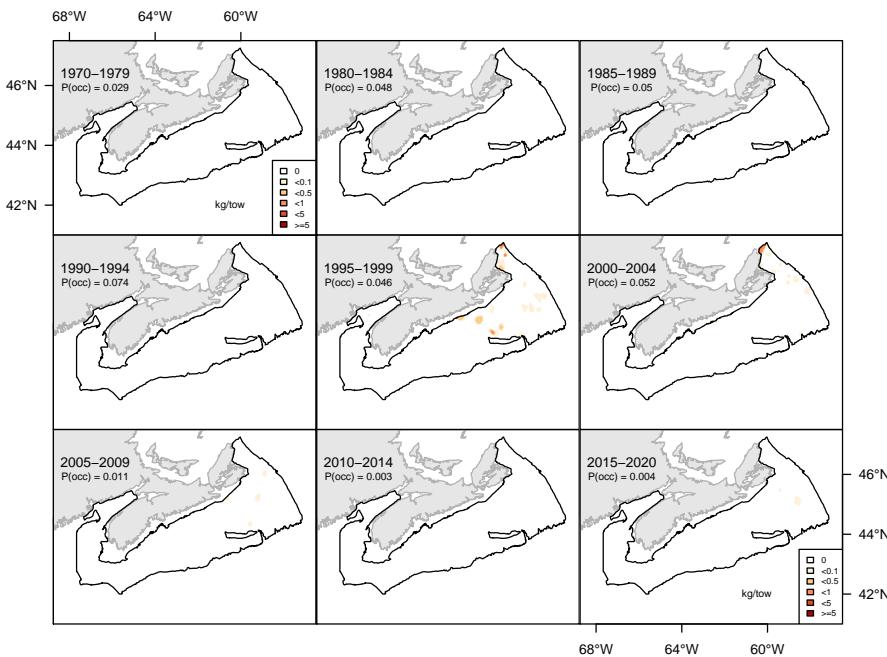


Figure 7.38A. Inverse distance weighted distribution of catch biomass (kg/tow) for Arctic hookear sculpin.

957

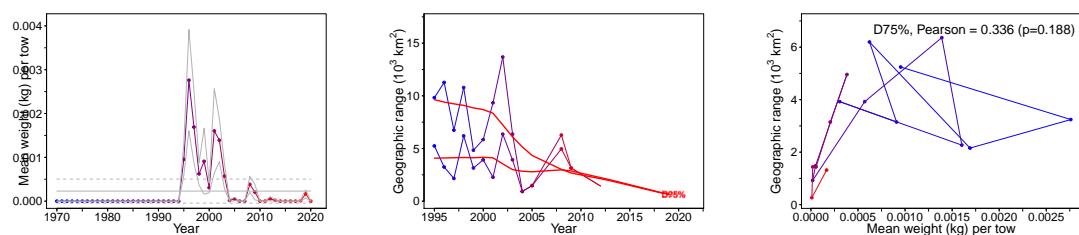


Figure 7.38B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Arctic hookear sculpin.

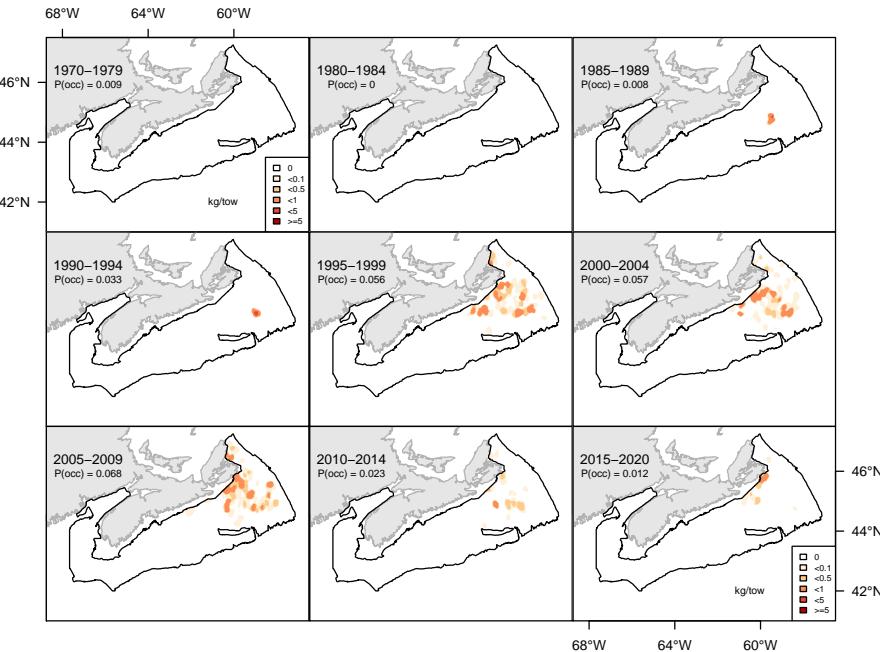
958

7.39 Atlantic poacher (*Agone atlantique*) - species code 350 (category LI)

959

Scientific name: [Leptagonus decagonus](#)

960



961

Figure 7.39A. Inverse distance weighted distribution of catch biomass (kg/tow) for Atlantic poacher.

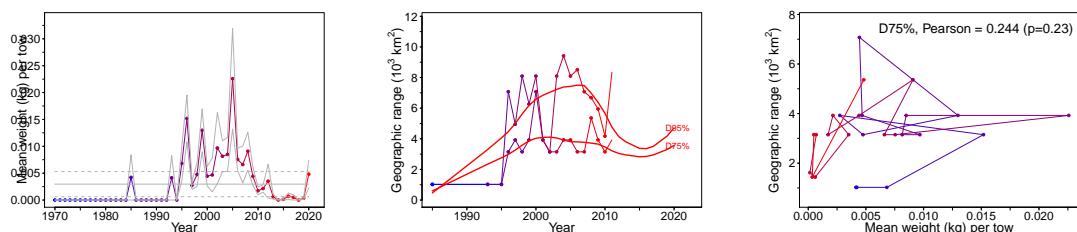


Figure 7.39B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Atlantic poacher.

962 **7.40 Marlin-spike grenadier (Grenadier du Grand Banc) - species code 410 (category**
 963 **LI)**

964 Scientific name: [Nezumia bairdii](#)

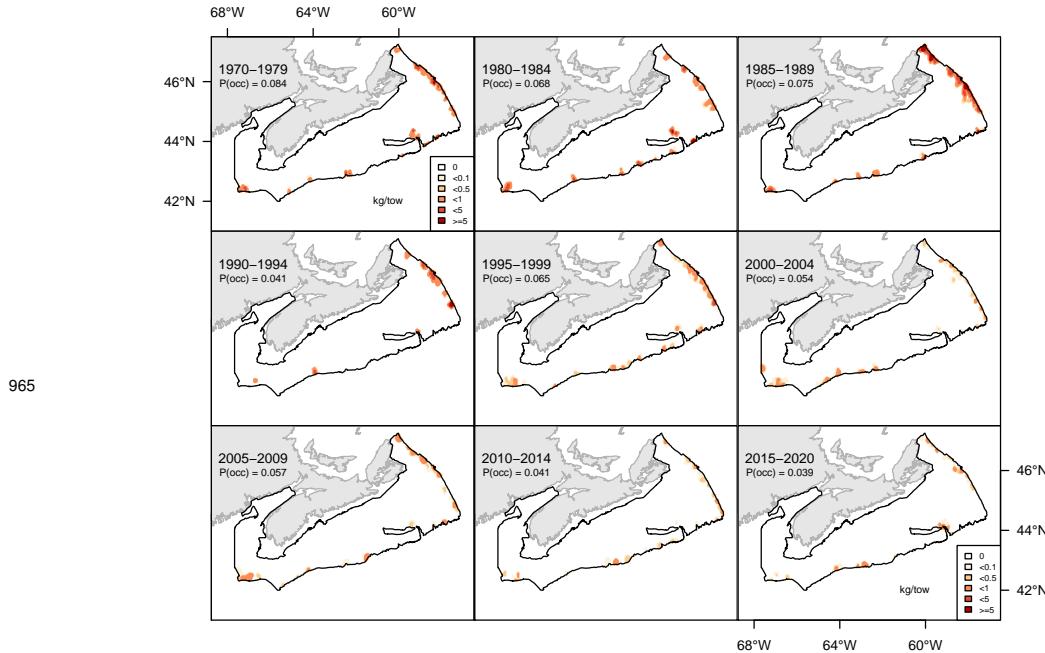


Figure 7.40A. Inverse distance weighted distribution of catch biomass (kg/tow) for Marlin-spike grenadier.

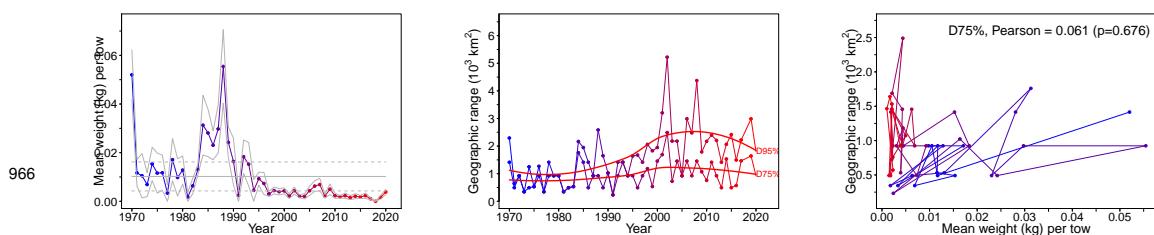


Figure 7.40B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Marlin-spike grenadier.

967 **7.41 Lumpfish (Lompe) - species code 501 (category LI)**

968 Scientific name: [Cyclopterus lumpus](#)

969

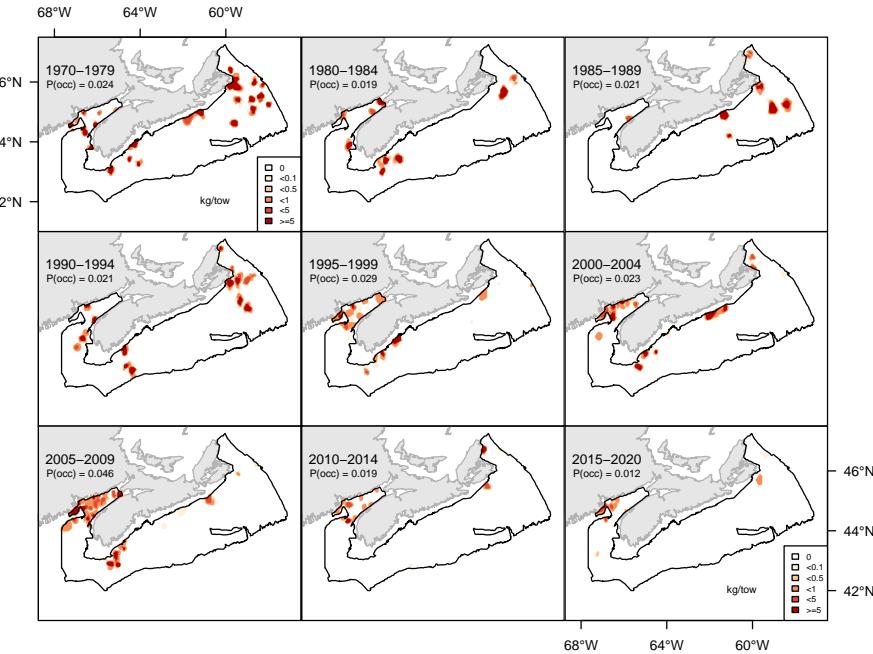


Figure 7.41A. Inverse distance weighted distribution of catch biomass (kg/tow) for Lumpfish.

970

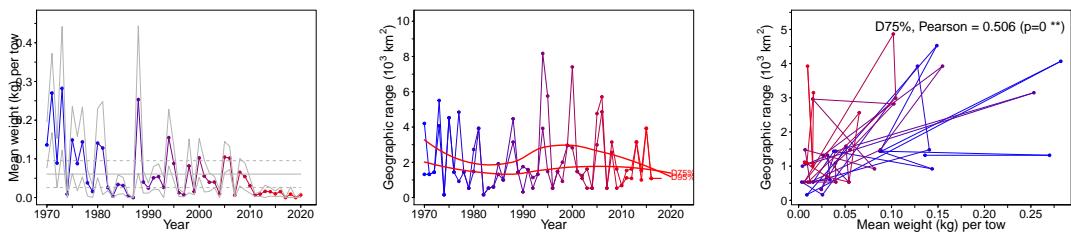


Figure 7.41B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Lumpfish.

971 **7.42 Atlantic spiny lumpsucker (Petite poule de mer atlantique) - species code 502**
 972 (**category LI**)

973 Scientific name: [Eumicrotremus spinosus](#)

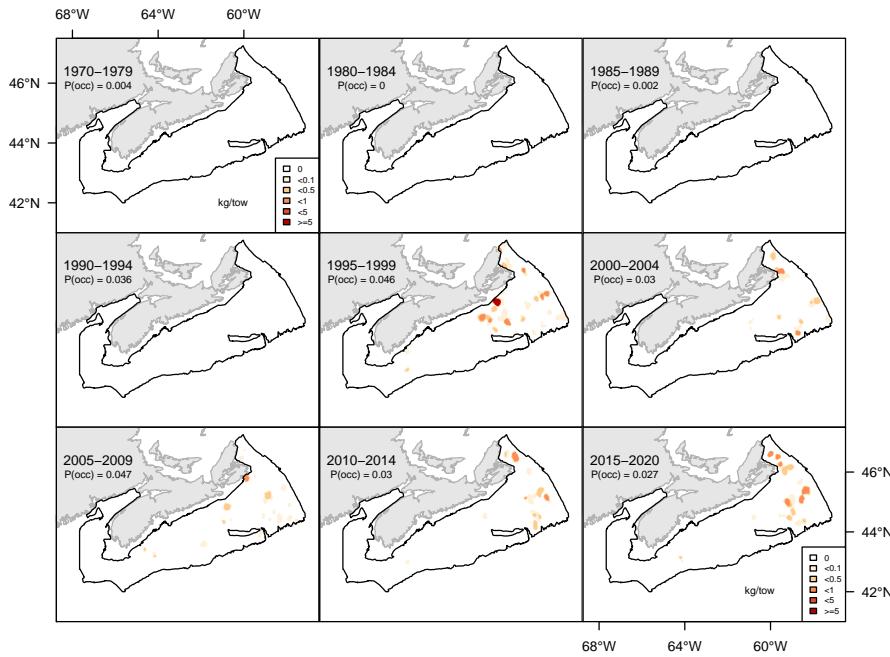


Figure 7.42A. Inverse distance weighted distribution of catch biomass (kg/tow) for Atlantic spiny lumpsucker.

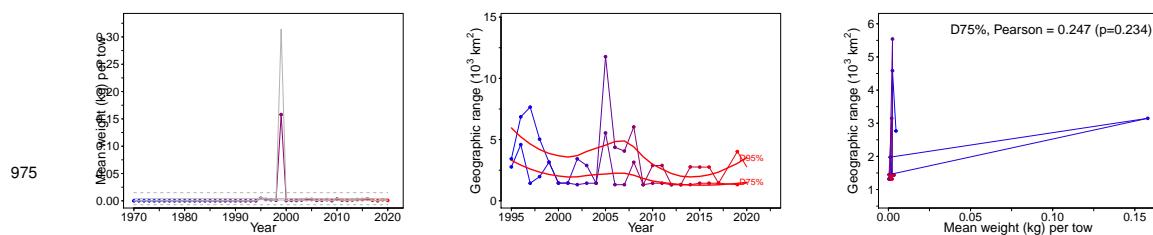


Figure 7.42B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Atlantic spiny lumpsucker.

976

7.43 Sand lance (Lançon) - species code 610 (category LI)

977

Scientific name: [Ammodytes dubius](#)

978

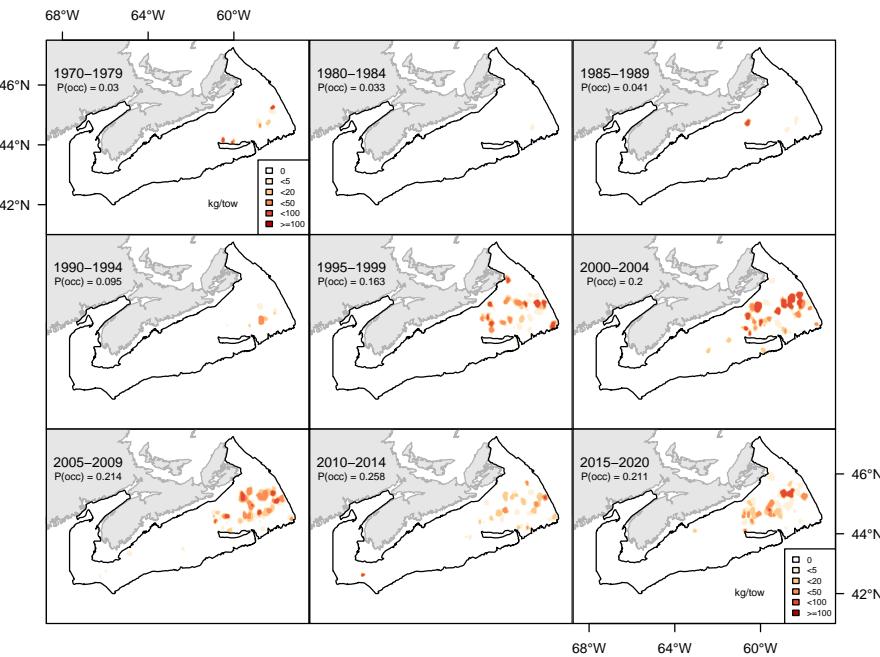


Figure 7.43A. Inverse distance weighted distribution of catch biomass (kg/tow) for Sand lance.

979

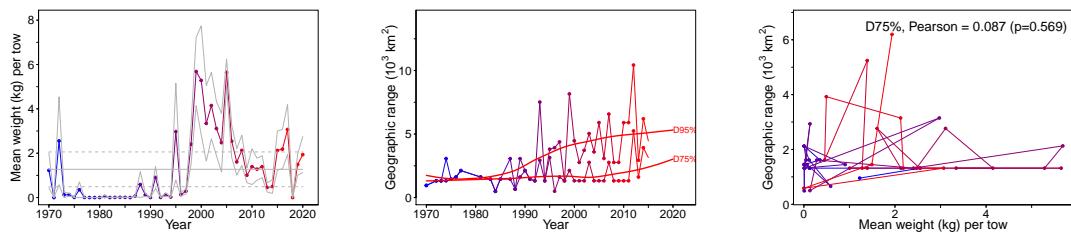


Figure 7.43B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Sand lance.

980

7.44 Snakeblenny (Lompénie-serpent) - species code 622 (category LI)

981

Scientific name: [Lumpenus lampretaeformis](#)

982

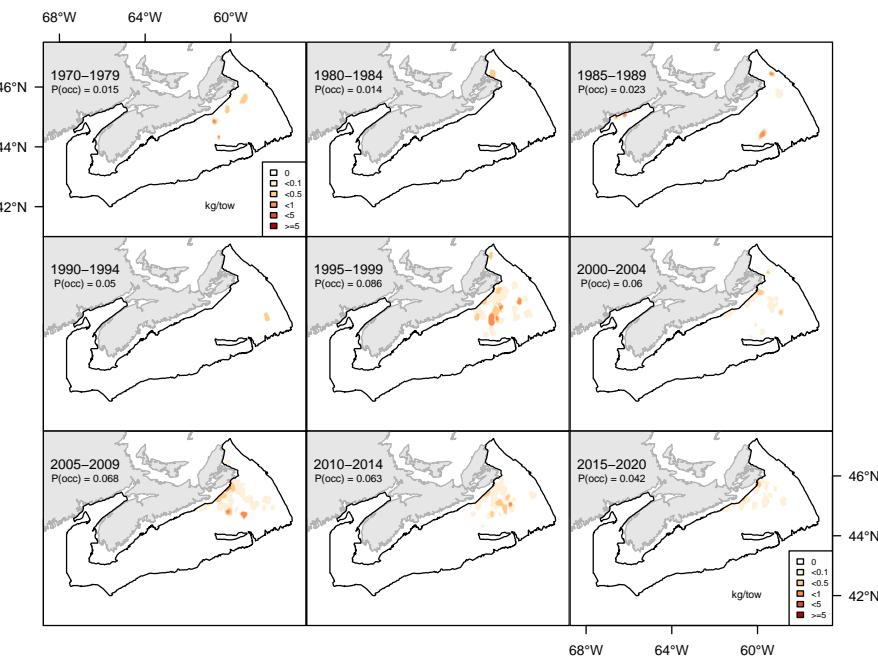


Figure 7.44A. Inverse distance weighted distribution of catch biomass (kg/tow) for Snakeblenny.

983

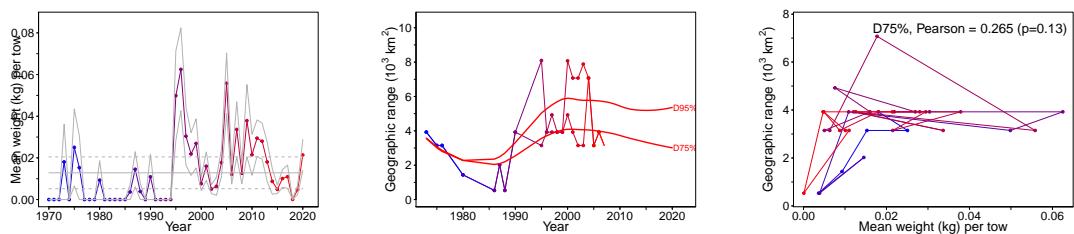


Figure 7.44B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Snakeblenny.

984

7.45 Daubed shanny (Lompénie tachetée) - species code 623 (category LI)

985

Scientific name: [Leptoclinus maculatus](#)

986

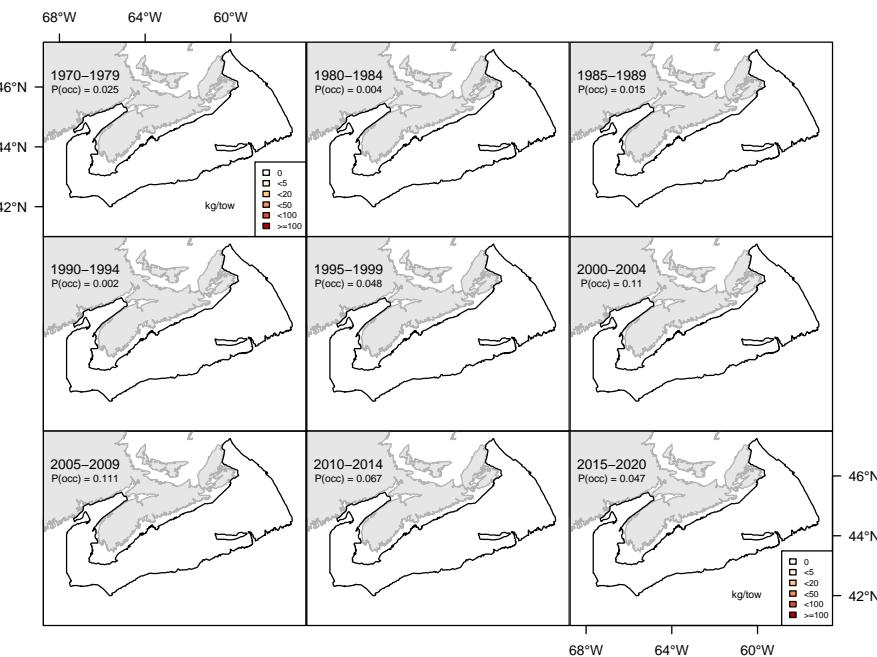


Figure 7.45A. Inverse distance weighted distribution of catch biomass (kg/tow) for Daubed shanny.

987

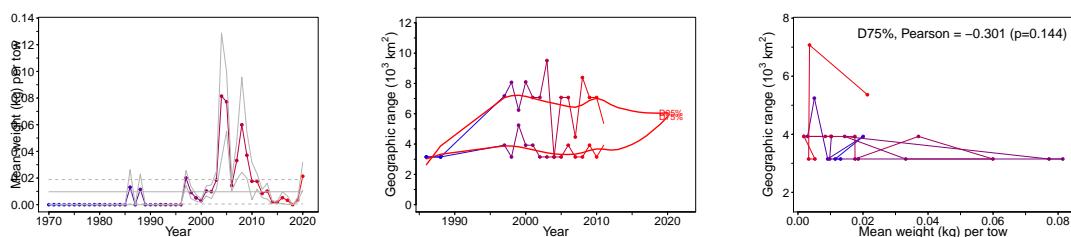


Figure 7.45B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Daubed shanny.

988

7.46 Vahl's eelpout (*Lycodes vahlii*) - species code 647 (category LI)

989

Scientific name: [Lycodes vahlii](#)

990

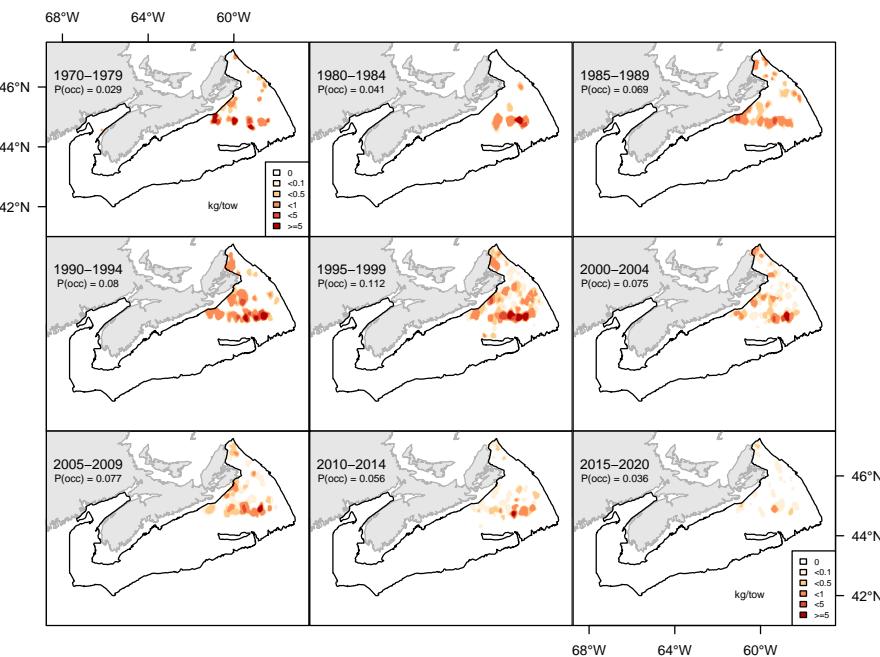


Figure 7.46A. Inverse distance weighted distribution of catch biomass (kg/tow) for Vahl's eelpout.

991

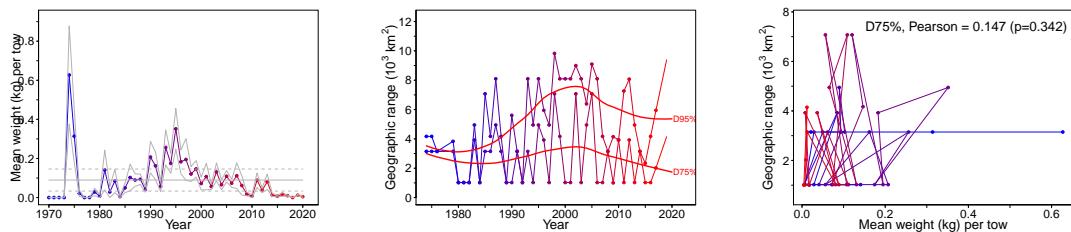


Figure 7.46B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Vahl's eelpout.

992 **7.47 Atlantic butterfish (*Stromaté fossette*) - species code 701 (category LI)**

993 Scientific name: [Peprilus triacanthus](#)

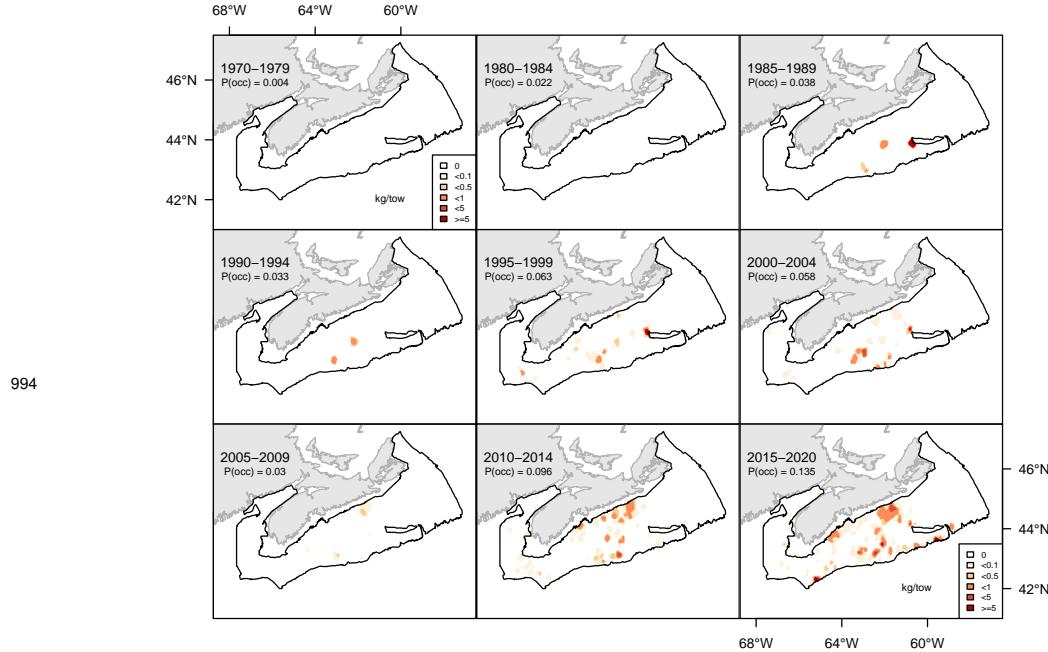


Figure 7.47A. Inverse distance weighted distribution of catch biomass (kg/tow) for Atlantic butterfish.

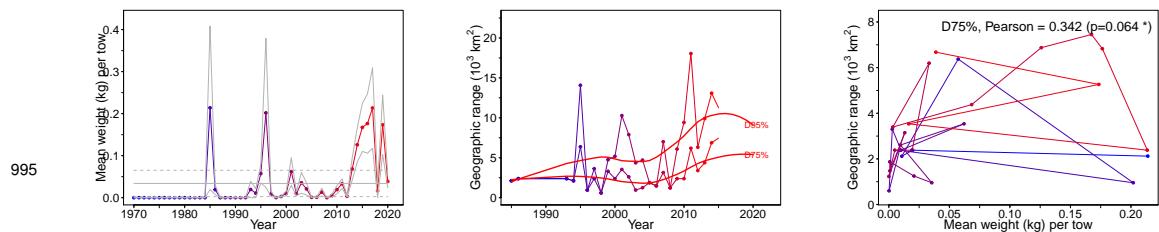


Figure 7.47B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Atlantic butterfish.

996 **7.48 Atlantic hookear sculpin (Hameçon atlantique) - species code 880 (category LI)**

997 Scientific name: [Artediellus atlanticus](#)

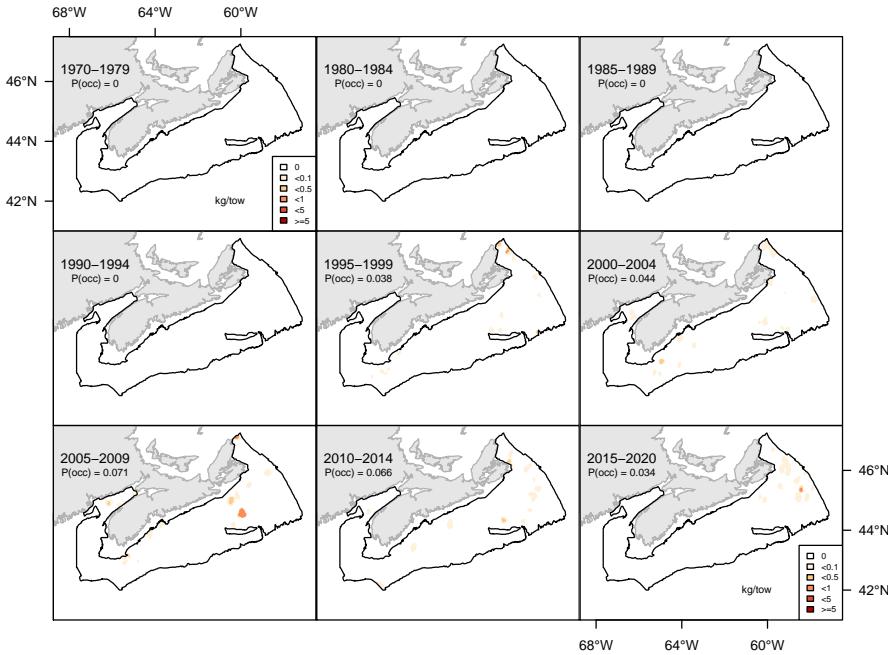


Figure 7.48A. Inverse distance weighted distribution of catch biomass (kg/tow) for Atlantic hookear sculpin.

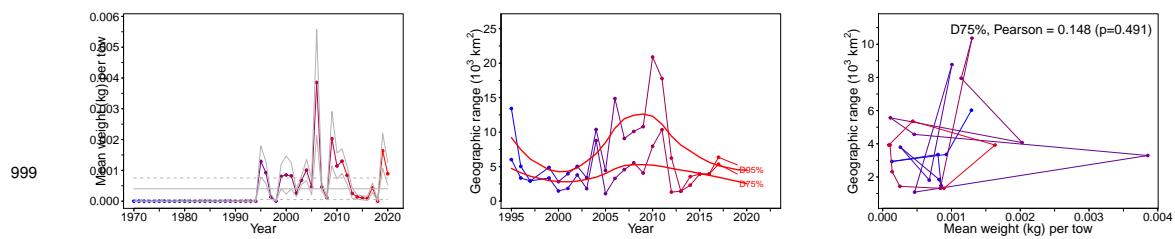


Figure 7.48B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Atlantic hookear sculpin.

1000 **7.49 Barndoor skate (Grande raie) - species code 200 (category LI)**

1001 Scientific name: *Dipturus laevis*

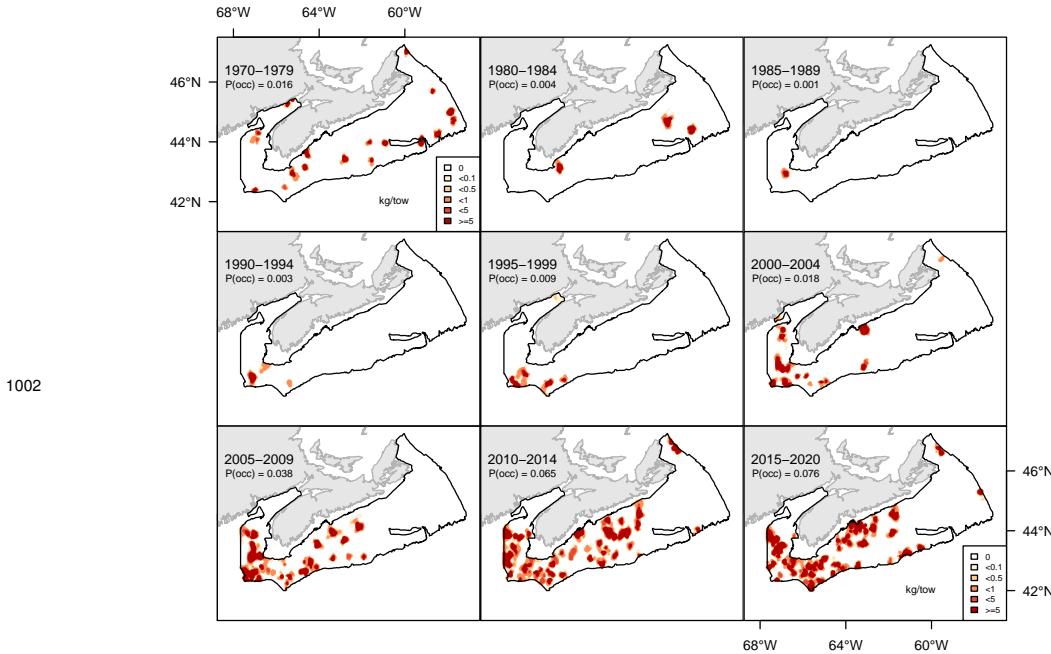


Figure 7.49A. Inverse distance weighted distribution of catch biomass (kg/tow) for Barndoor skate.

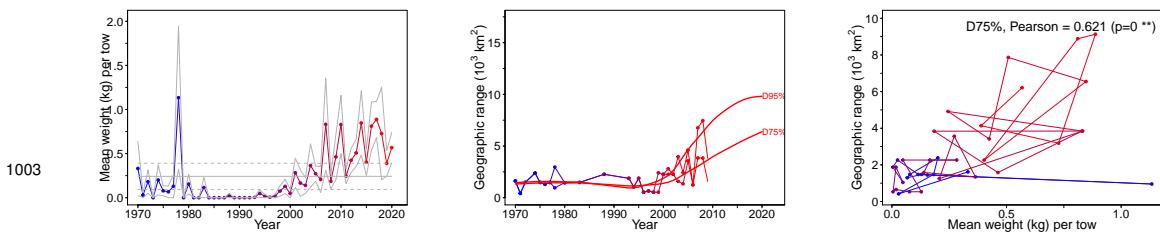


Figure 7.49B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Barndoor skate.

1004

7.50 Little skate (Raie hérisson) - species code 203 (category LI)

1005

Scientific name: [Leucoraja erinacea](#)

1006

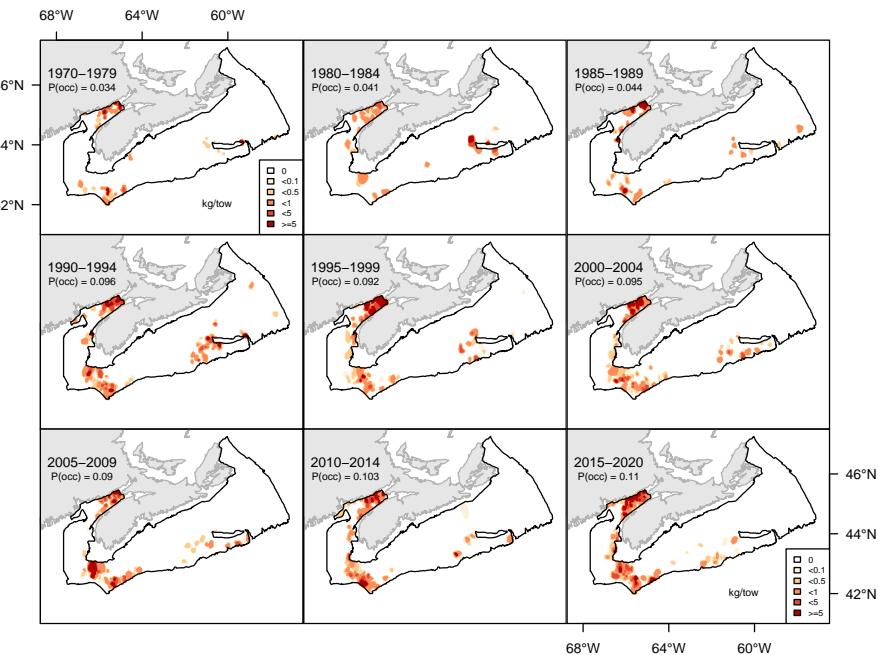


Figure 7.50A. Inverse distance weighted distribution of catch biomass (kg/tow) for Little skate.

1007

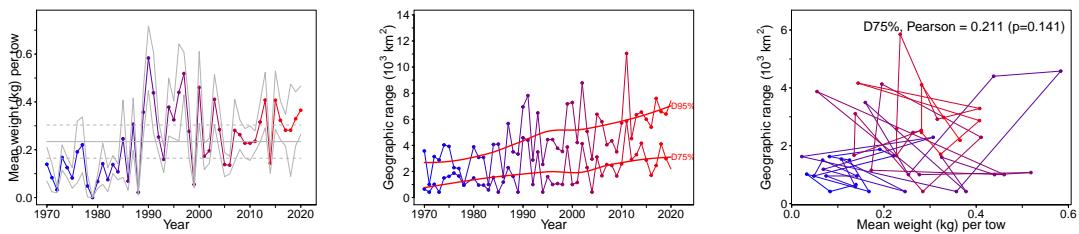


Figure 7.50B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Little skate.

1008

7.51 Northern prawn (Crevette nordique) - species code 2211 (category SF)

1009

Scientific name: [Pandalus borealis](#)

1010

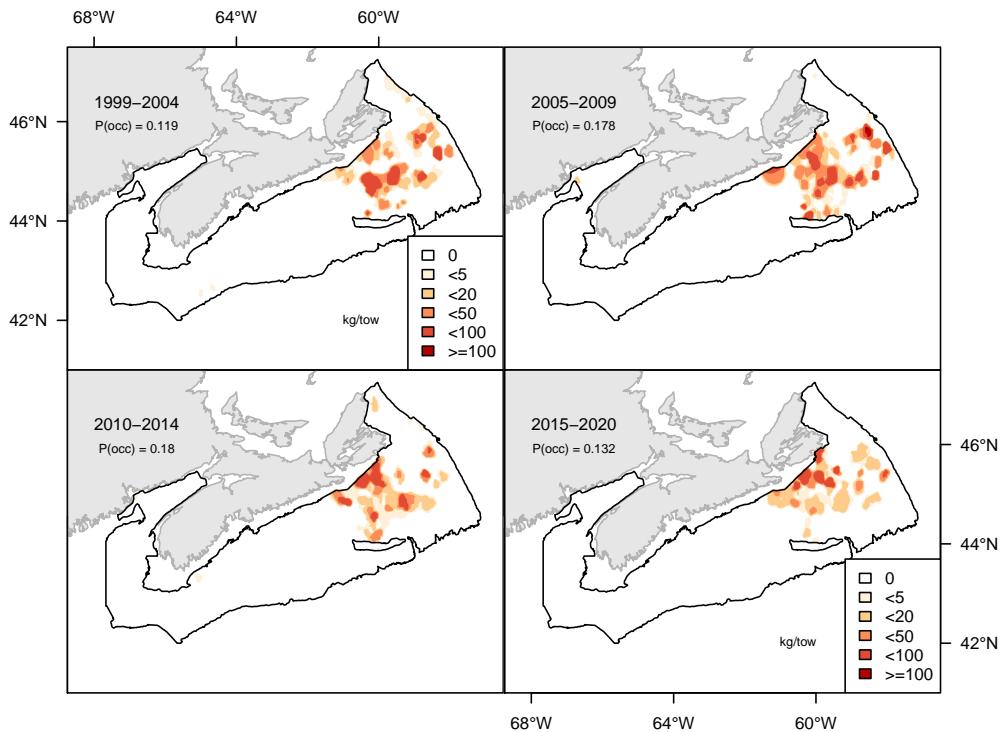


Figure 7.51A. Inverse distance weighted distribution of catch biomass (kg/tow) for Northern prawn.

1011

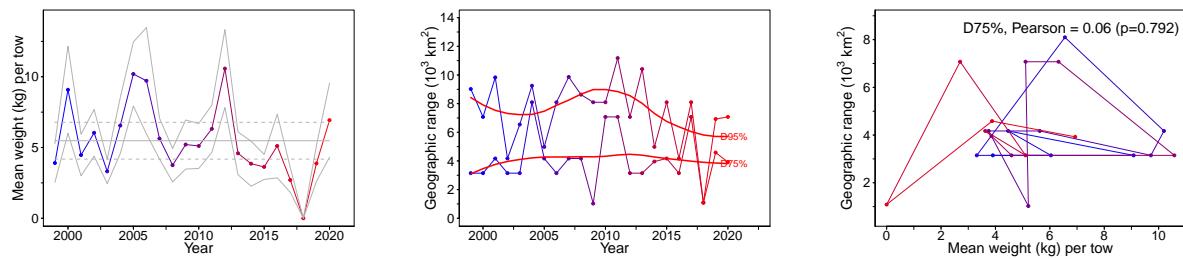


Figure 7.51B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Northern prawn.

1012

7.52 Jonah crab (Tourteau jona) - species code 2511 (category SF)

1013

Scientific name: [Cancer borealis](#)

1014

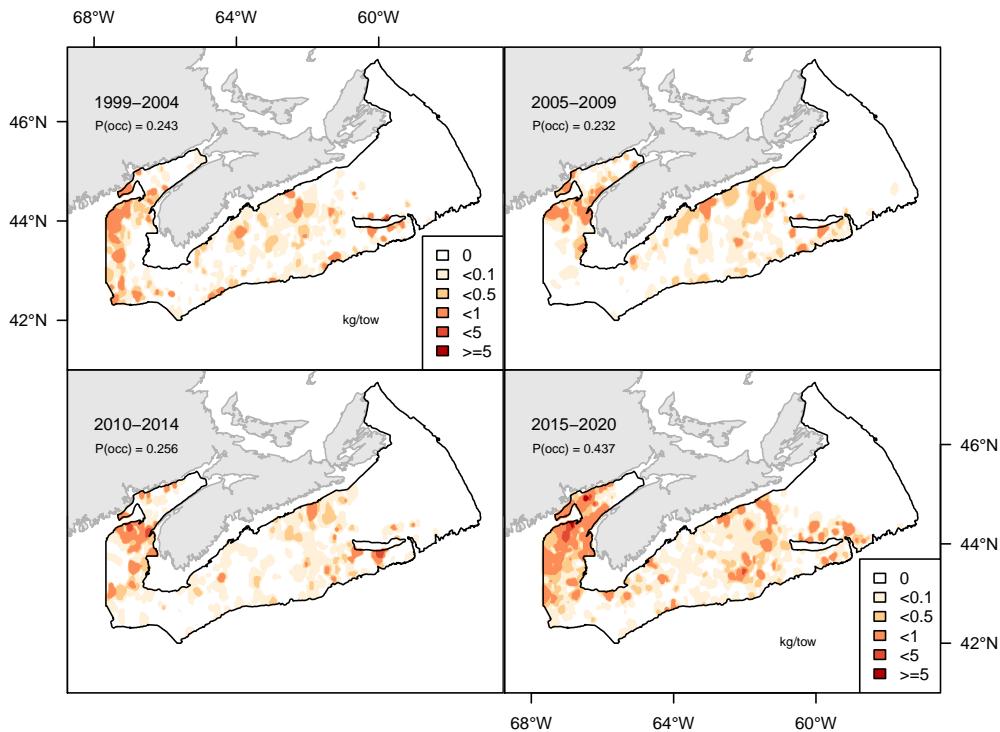


Figure 7.52A. Inverse distance weighted distribution of catch biomass (kg/tow) for Jonah crab.

1015

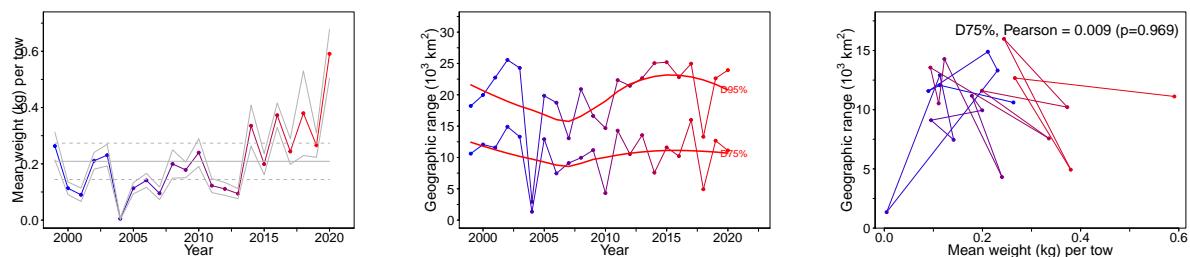


Figure 7.52B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Jonah crab.

1016

7.53 Atlantic rock crab (Tourteau poïnclos) - species code 2513 (category SF)

1017

Scientific name: [Cancer irroratus](#)

1018

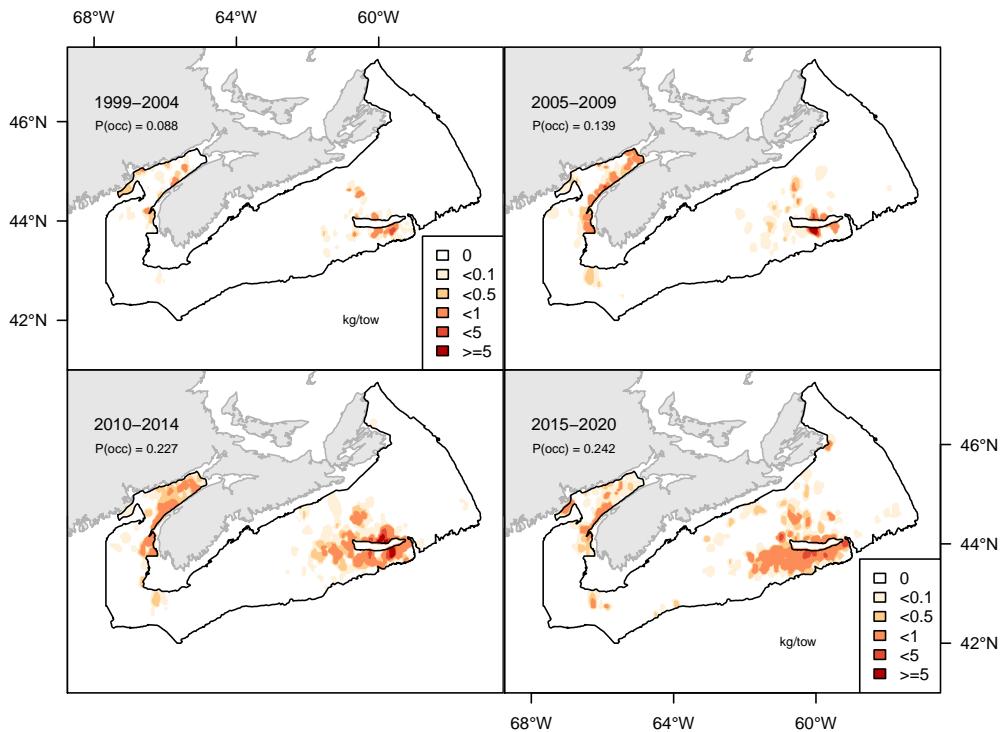


Figure 7.53A. Inverse distance weighted distribution of catch biomass (kg/tow) for Atlantic rock crab.

1019

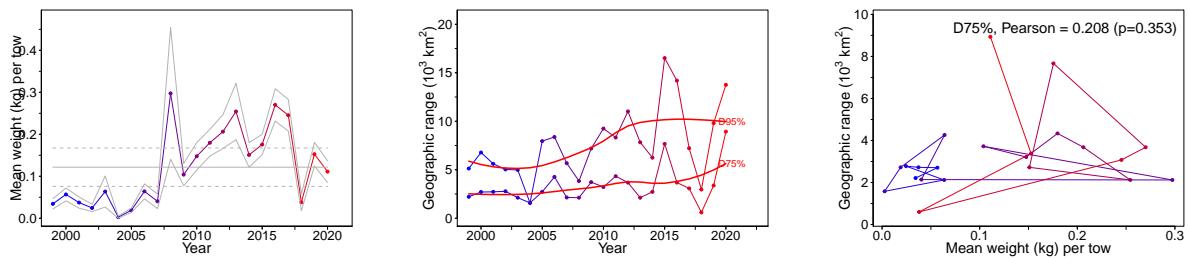


Figure 7.53B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Atlantic rock crab.

1020

7.54 Arctic lyre crab (*Crabe Hyas coarctatus*) - species code 2521 (category SF)

1021

Scientific name: [Hyas coarctatus](#)

1022

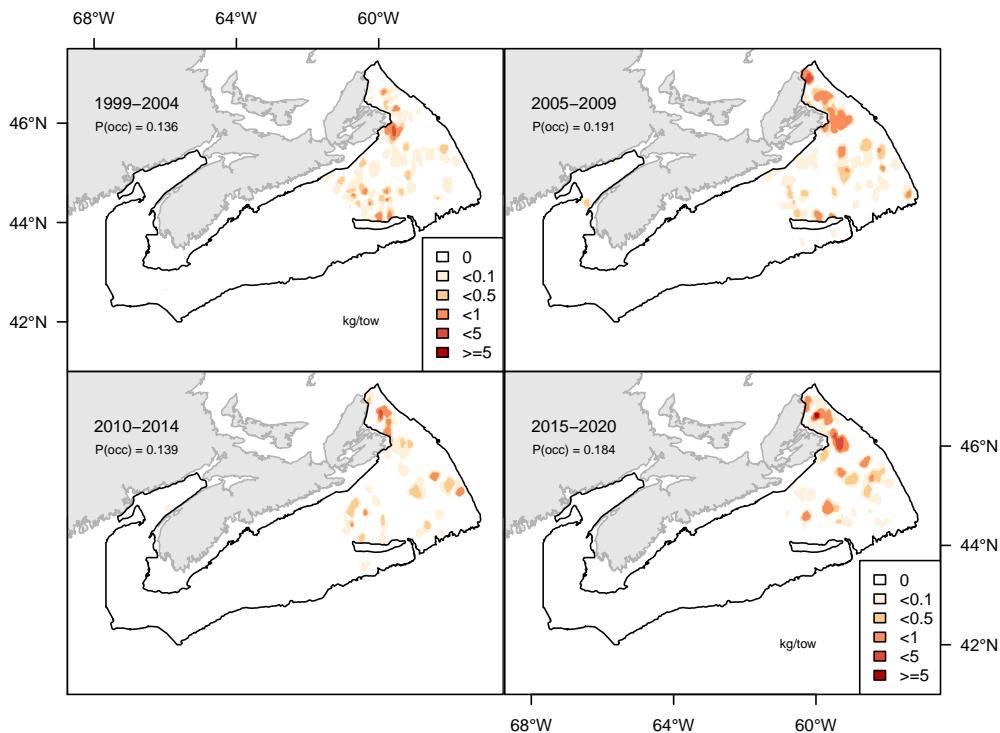


Figure 7.54A. Inverse distance weighted distribution of catch biomass (kg/tow) for Arctic lyre crab.

1023

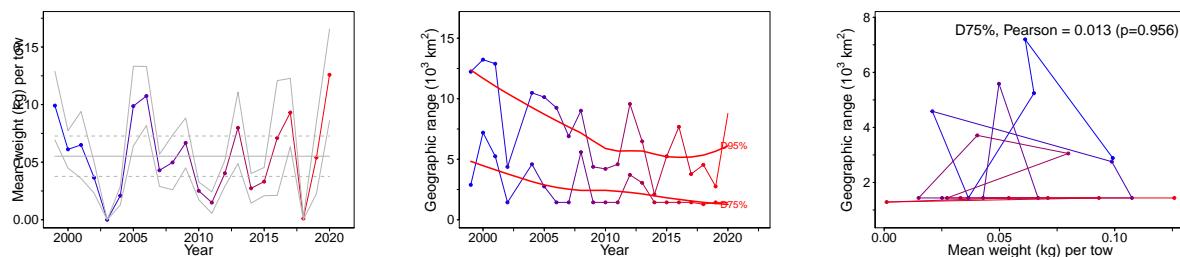


Figure 7.54B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Arctic lyre crab.

1024

7.55 Atlantic king crab (Crabe épineux du nord) - species code 2523 (category SF)

1025

Scientific name: [Lithodes maja](#)

1026

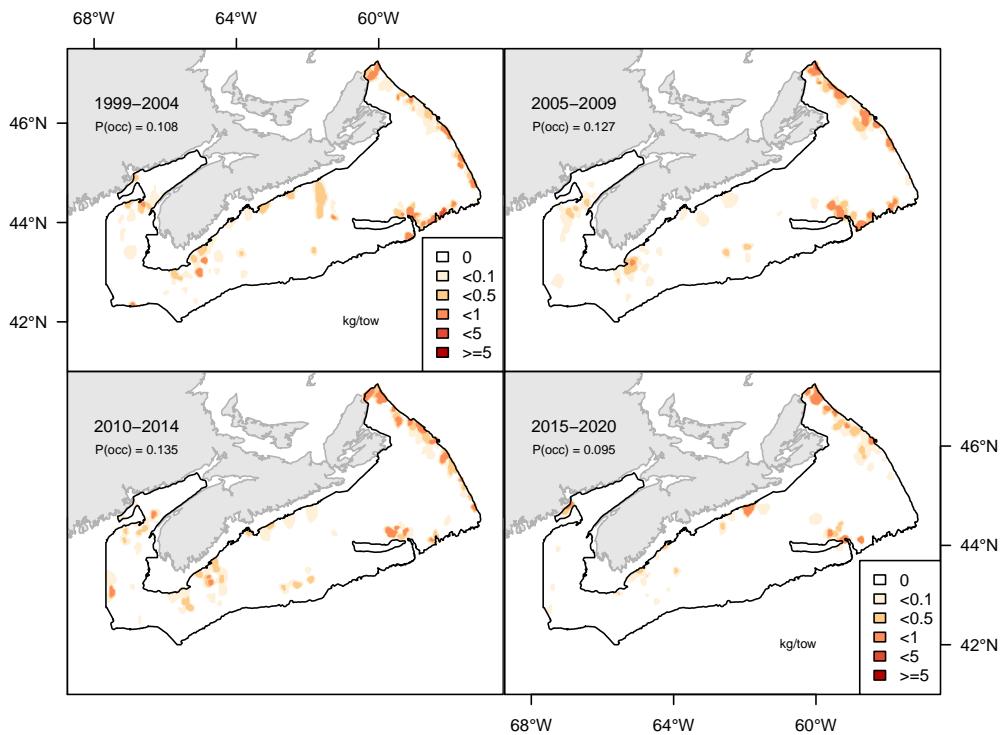


Figure 7.55A. Inverse distance weighted distribution of catch biomass (kg/tow) for Atlantic king crab.

1027

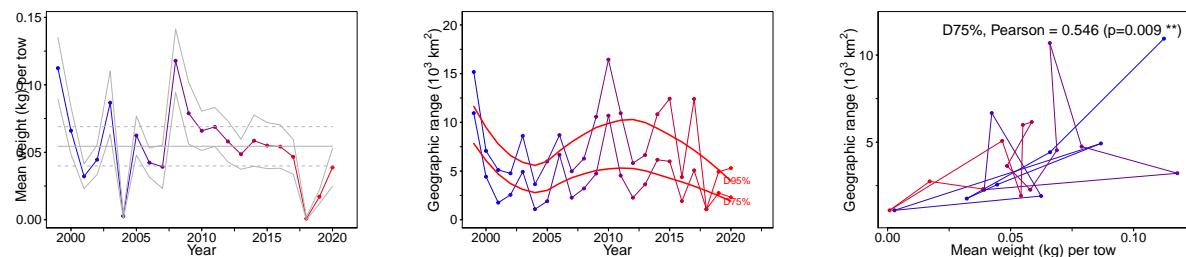


Figure 7.55B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Atlantic king crab.

1028

7.56 Queen crab (Crabe des neiges) - species code 2526 (category SF)

1029

Scientific name: [Chionoecetes opilio](#)

1030

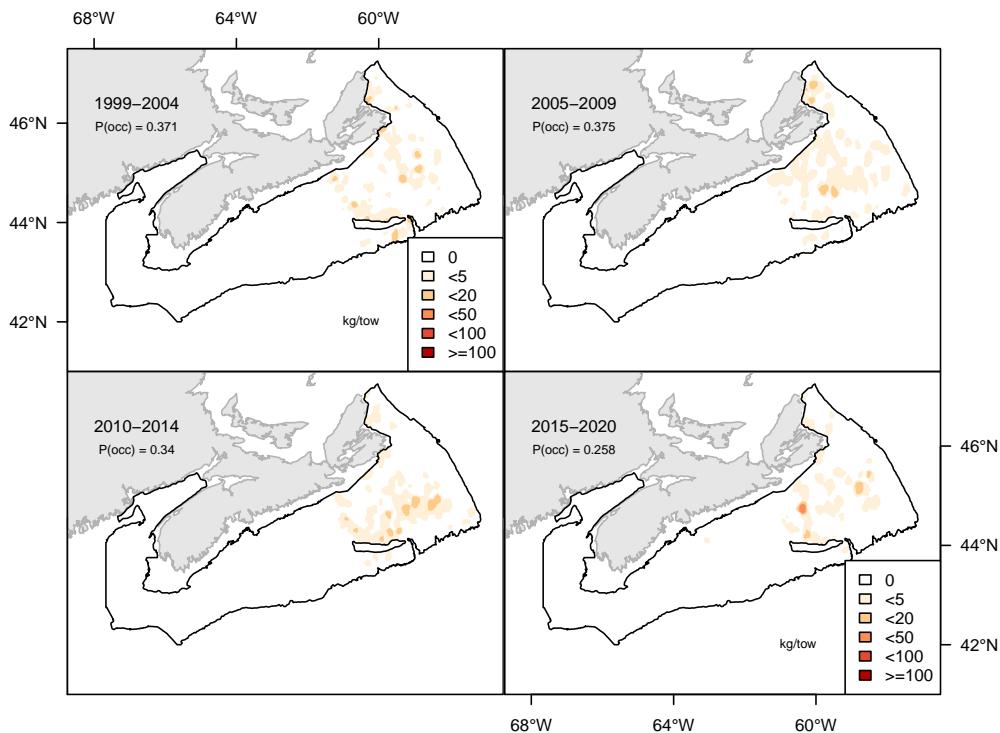


Figure 7.56A. Inverse distance weighted distribution of catch biomass (kg/tow) for Queen crab.

1031

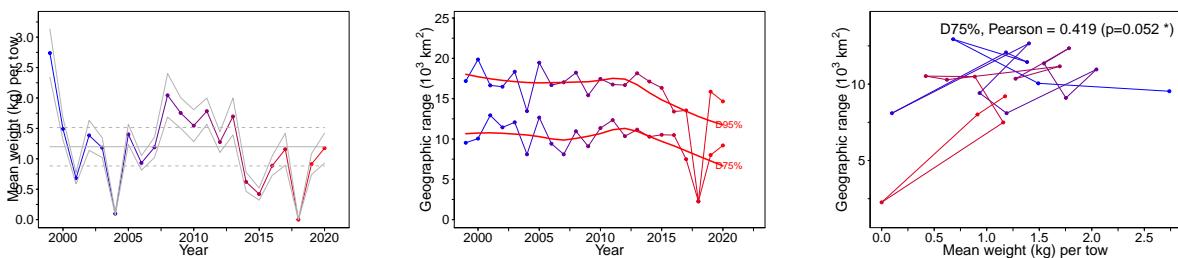


Figure 7.56B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Queen crab.

1032

7.57 Great spider crab (Crabe lyre araignée) - species code 2527 (category SF)

1033

Scientific name: [Hyas araneus](#)

1034

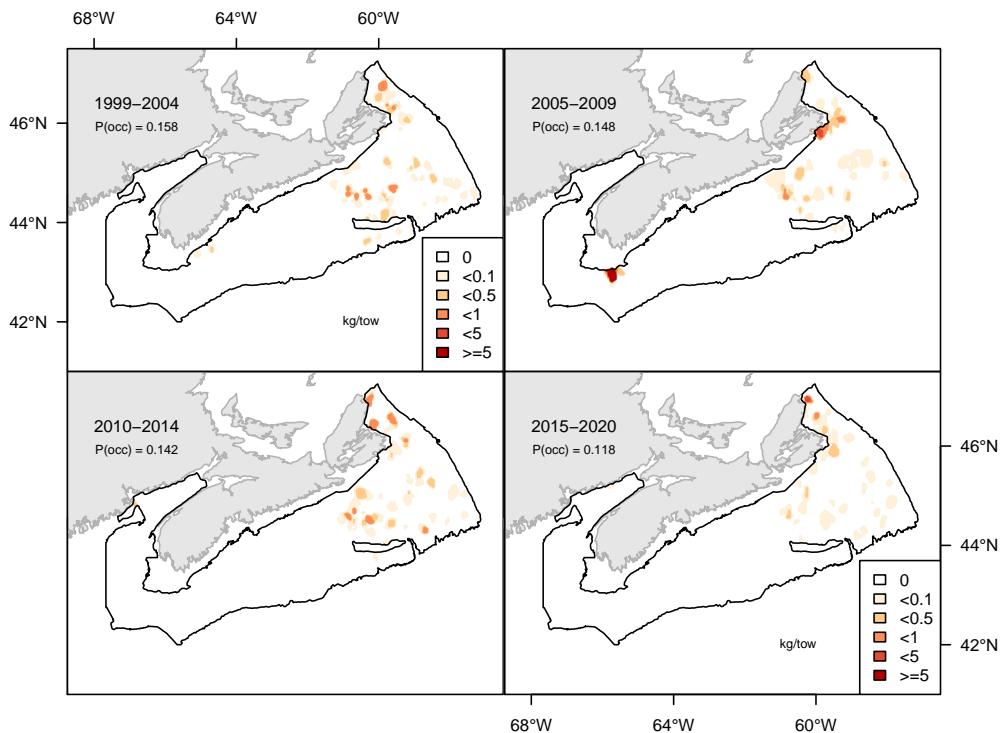


Figure 7.57A. Inverse distance weighted distribution of catch biomass (kg/tow) for Great spider crab.

1035

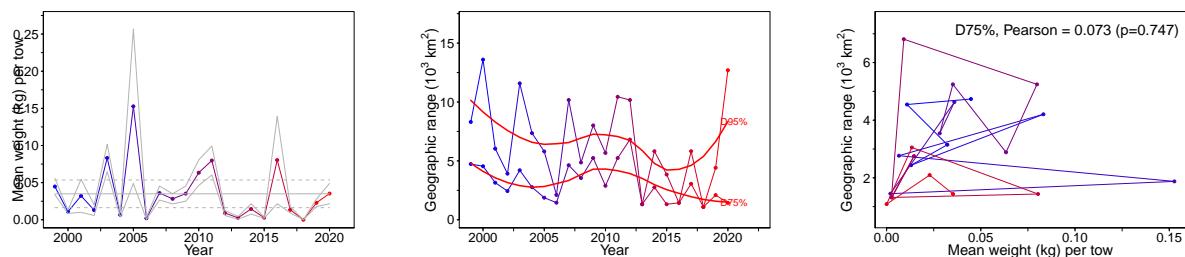


Figure 7.57B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Great spider crab.

1036

7.58 American lobster (Homard américain) - species code 2550 (category SF)

1037

Scientific name: [Homarus americanus](#)

1038

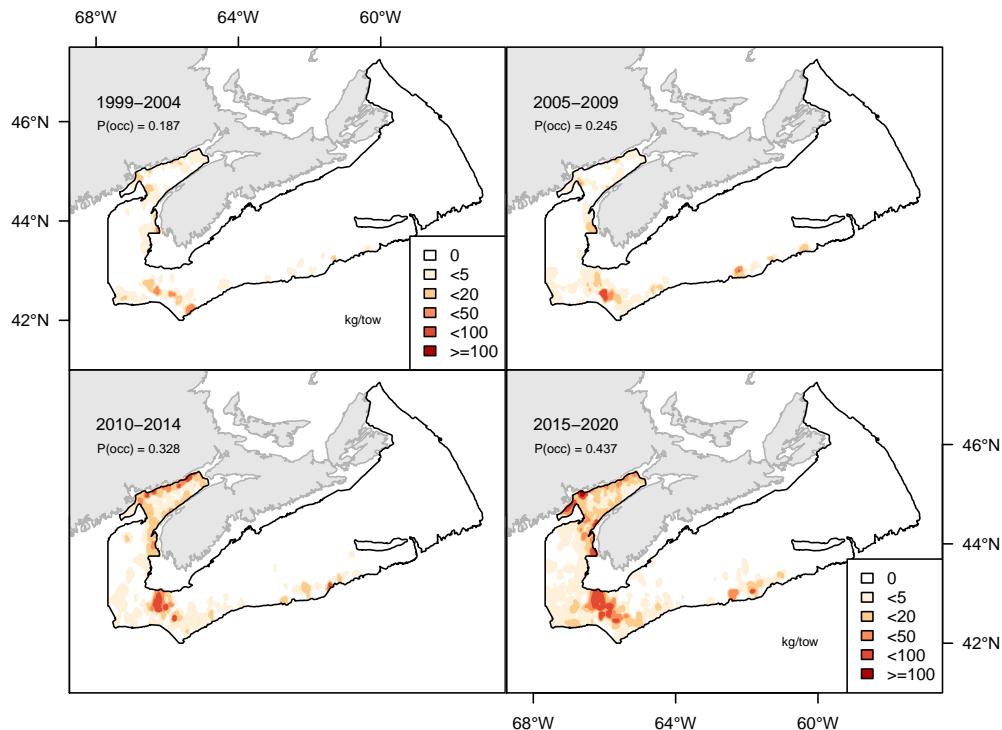


Figure 7.58A. Inverse distance weighted distribution of catch biomass (kg/tow) for American lobster.

1039

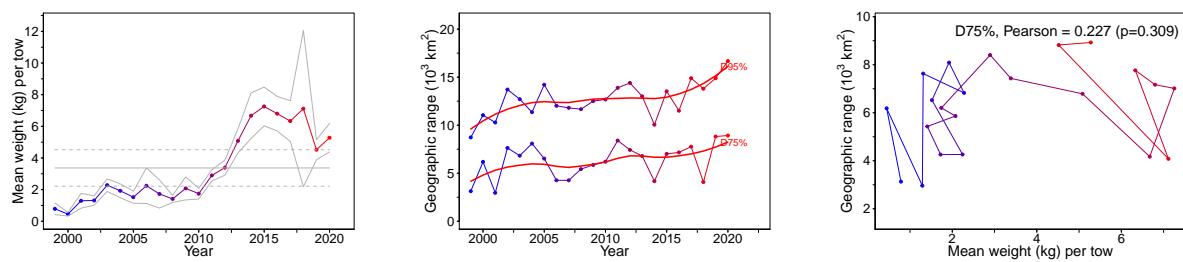


Figure 7.58B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of American lobster.

1040

7.59 Sea lamprey (*Lamproie marine*) - species code 240 (category LR)

1041

Scientific name: [Petromyzon marinus](#)

1042

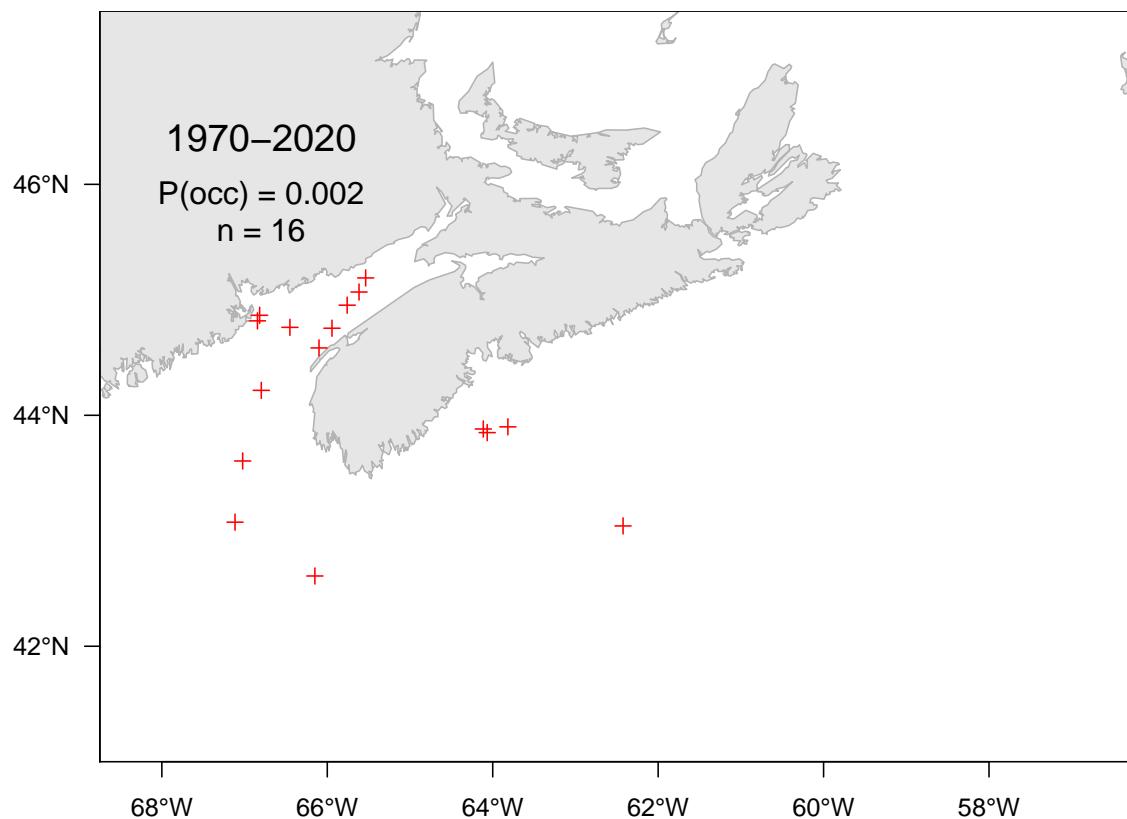


Figure 7.59A. Catch distribution for Sea lamprey.

1043

7.60 Atlantic tomcod (*Poulamon atlantique*) - species code 17 (category LR)

1044

Scientific name: [Microgadus tomcod](#)

1045

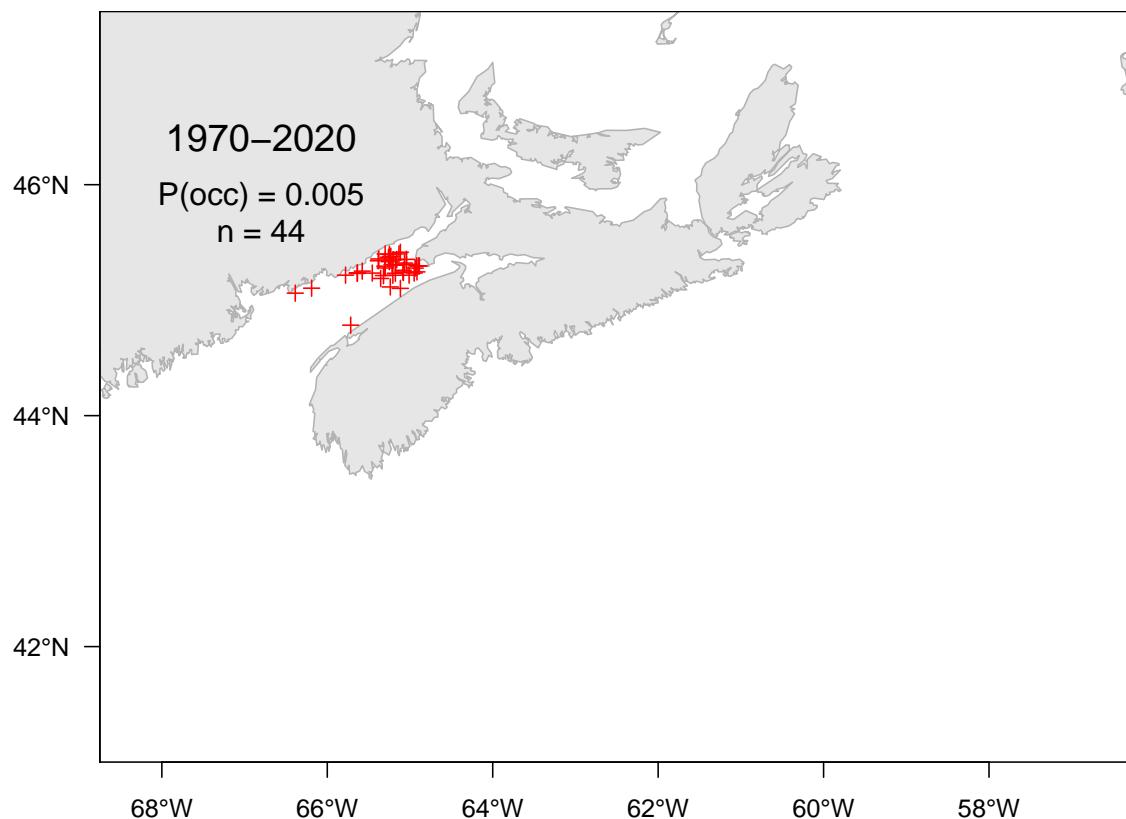


Figure 7.60A. Catch distribution for Atlantic tomcod.

1046

7.61 Offshore silver hake (Merlu argenté du large) - species code 19 (category LR)

1047

Scientific name: [Merluccius albidus](#)

1048

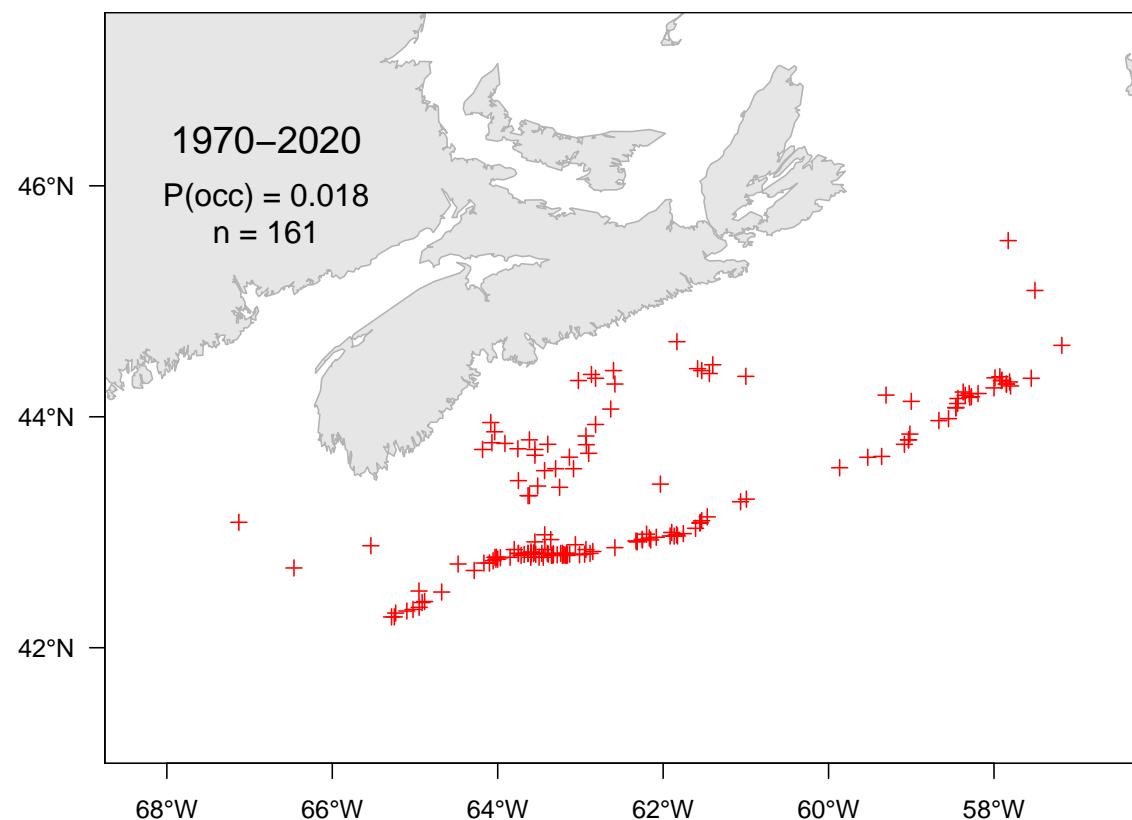


Figure 7.61A. Catch distribution for Offshore silver hake.

1049

7.62 Spotted wolffish (Loup tacheté) - species code 51 (category LR)

1050

Scientific name: [Anarhichas minor](#)

1051

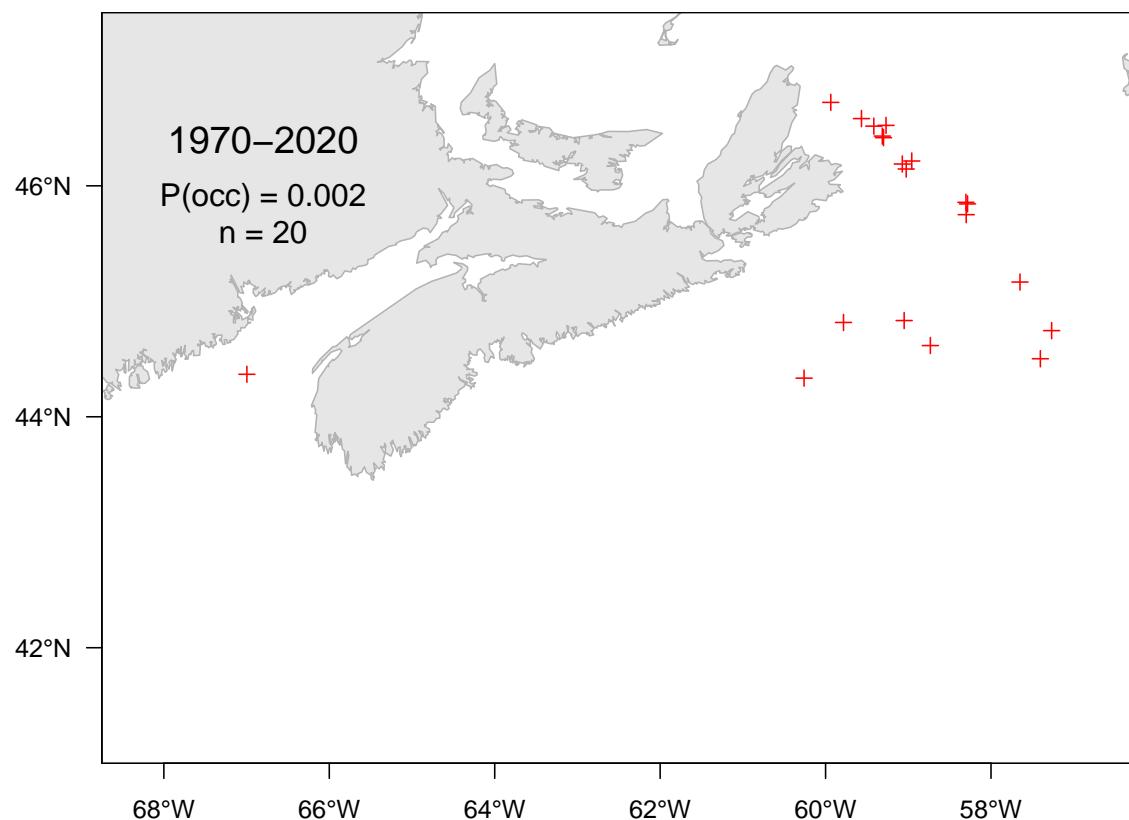


Figure 7.62A. Catch distribution for Spotted wolffish.

1052

7.63 Northern wolffish (Loup à tête large) - species code 52 (category LR)

1053

Scientific name: [Anarhichas denticulatus](#)

1054

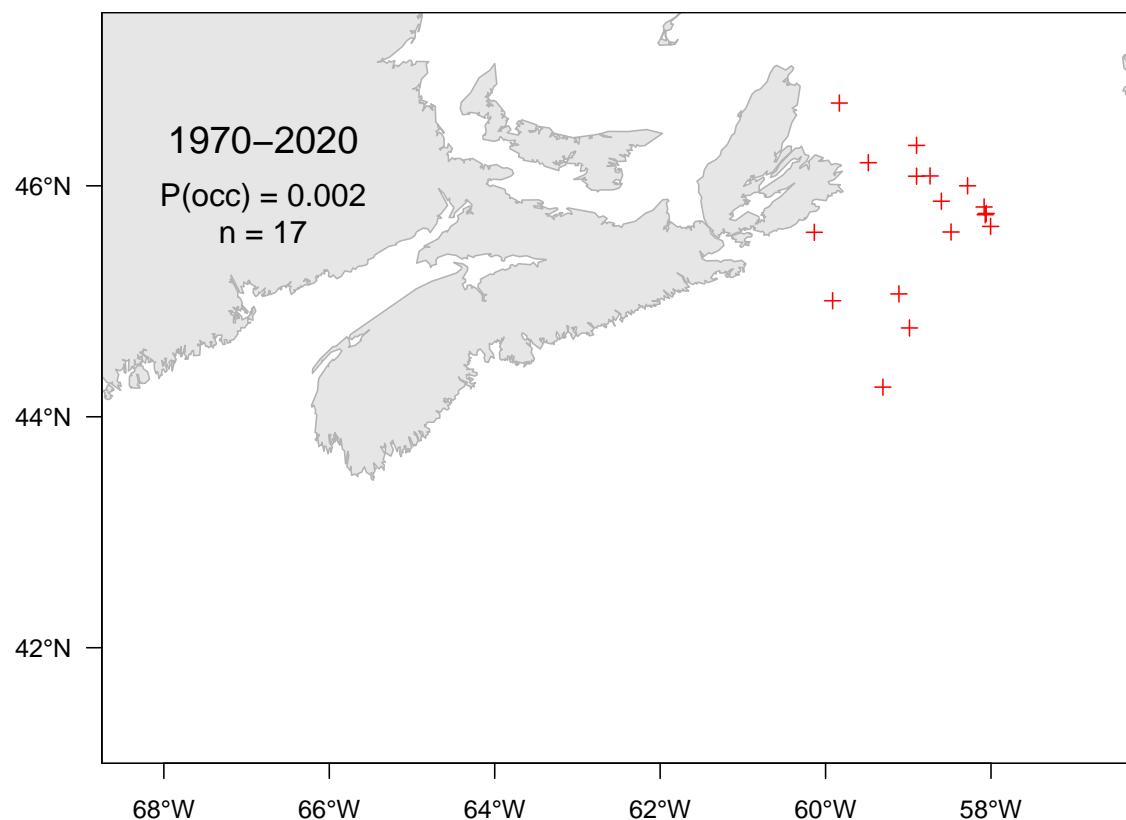


Figure 7.63A. Catch distribution for Northern wolffish.

1055

7.64 Rainbow smelt (Éperlan arc-en-ciel) - species code 63 (category LR)

1056

Scientific name: [Osmerus mordax](#)

1057

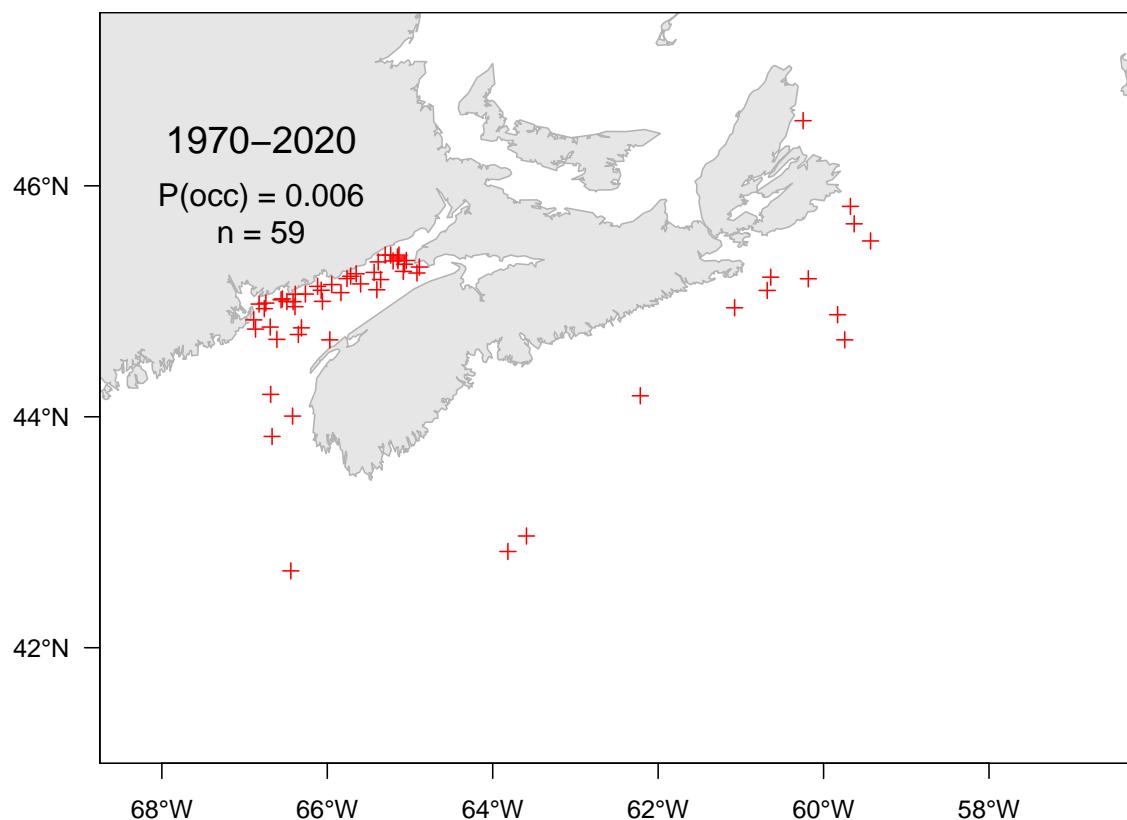


Figure 7.64A. Catch distribution for Rainbow smelt.

1058

7.65 Cunner (Tanche-tautogue) - species code 122 (category LR)

1059

Scientific name: [Tautogolabrus adspersus](#)

1060

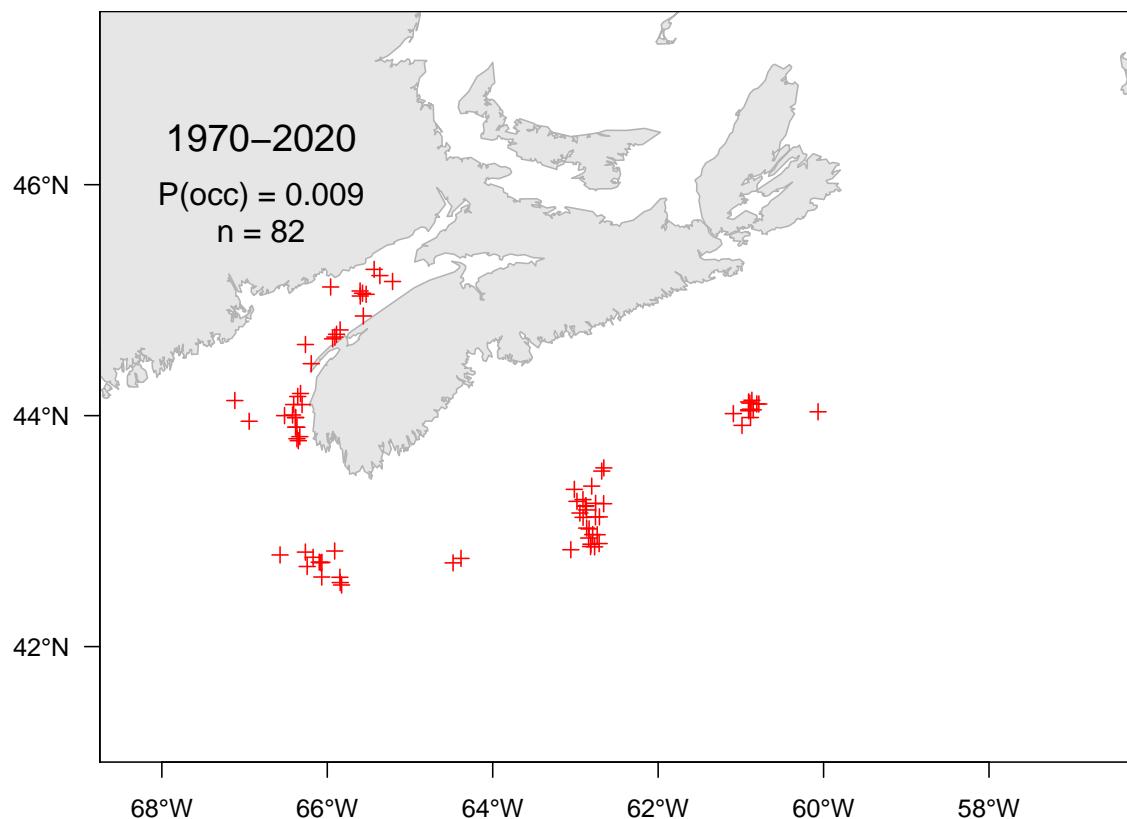


Figure 7.65A. Catch distribution for Cunner.

1061

7.66 Fourspot flounder (Cardeau à quatre ocelles) - species code 142 (category LR)

1062

Scientific name: [Hippoglossina oblonga](#)

1063

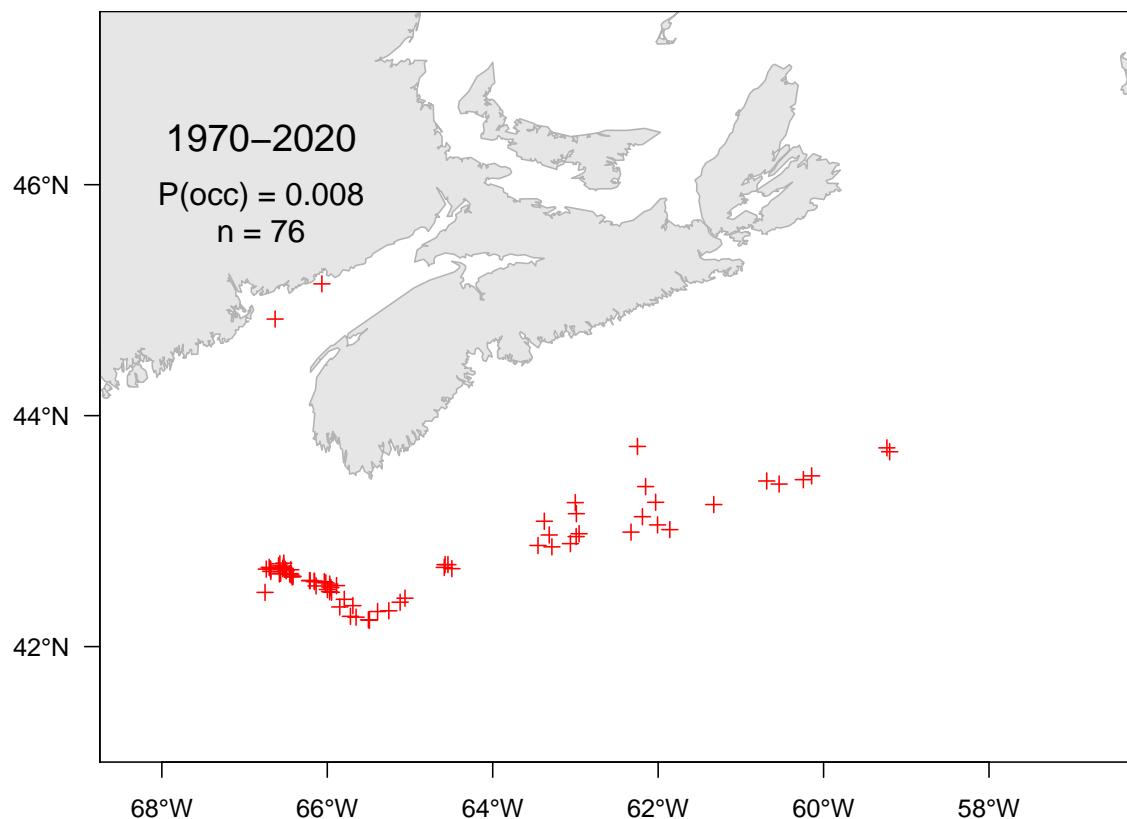


Figure 7.66A. Catch distribution for Fourspot flounder.

1064

7.67 Windowpane flounder (Turbot de sable) - species code 143 (category LR)

1065

Scientific name: [Scophthalmus aquosus](#)

1066

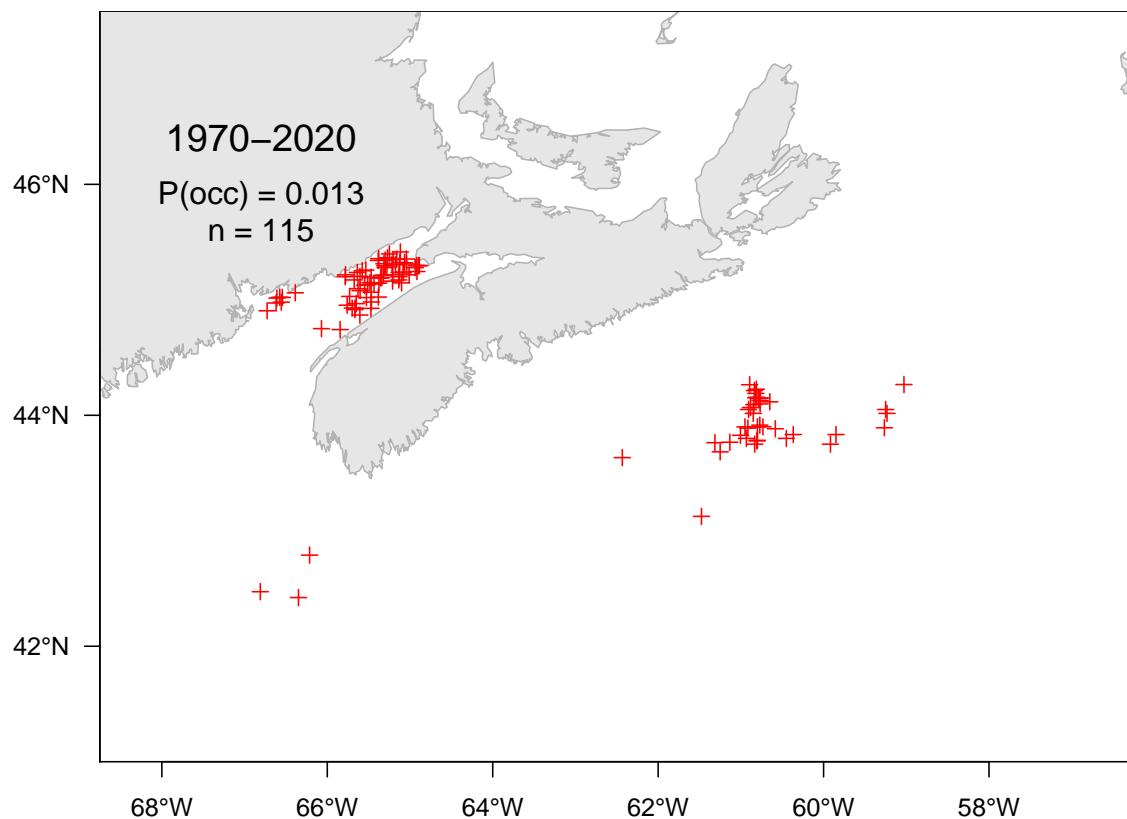


Figure 7.67A. Catch distribution for Windowpane flounder.

1067 **7.68 Longnose greeneye (Oeil-vert à long nez) - species code 149 (category LR)**

1068 Scientific name: [Parasudis triculenta](#)

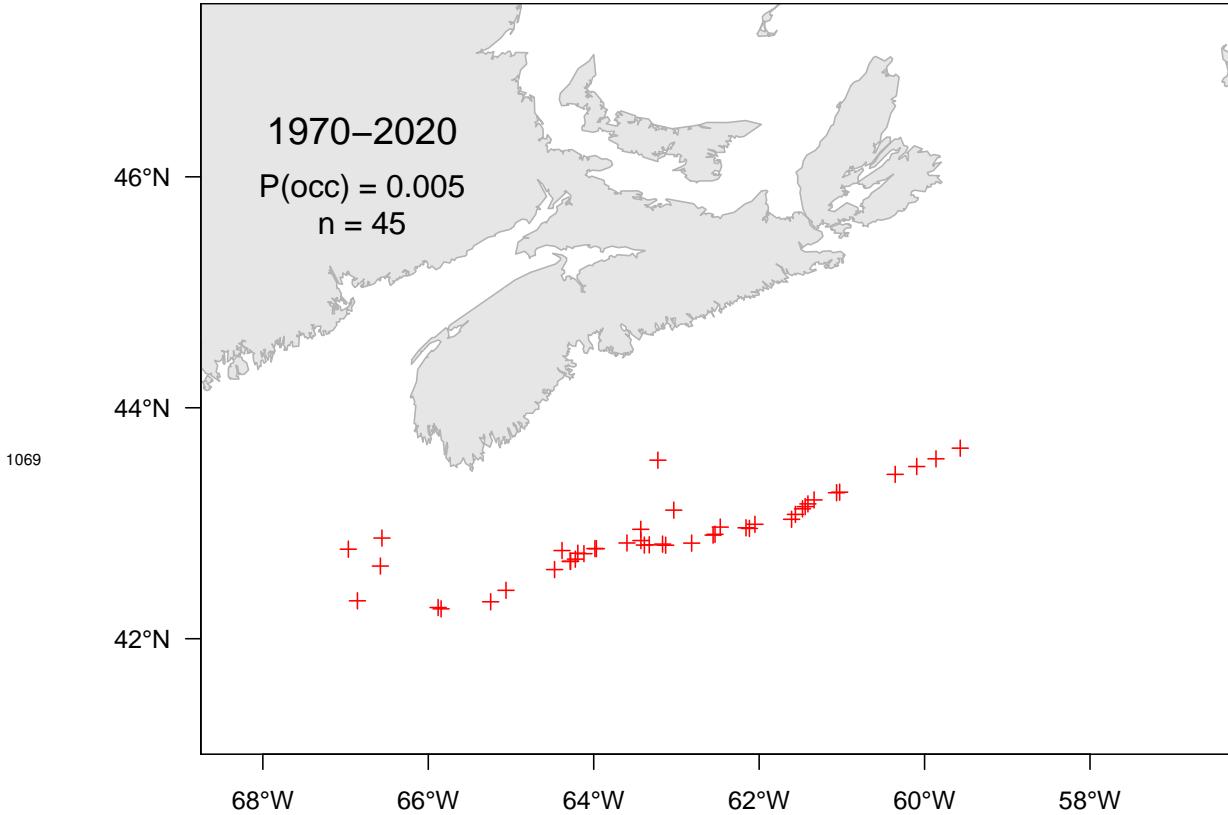


Figure 7.68A. Catch distribution for Longnose greeneye.

1070

7.69 Lanternfishes (Poissons-lanternes) - species code 150 (category LR)

1071

Scientific name: [Myctophidae](#)

1072

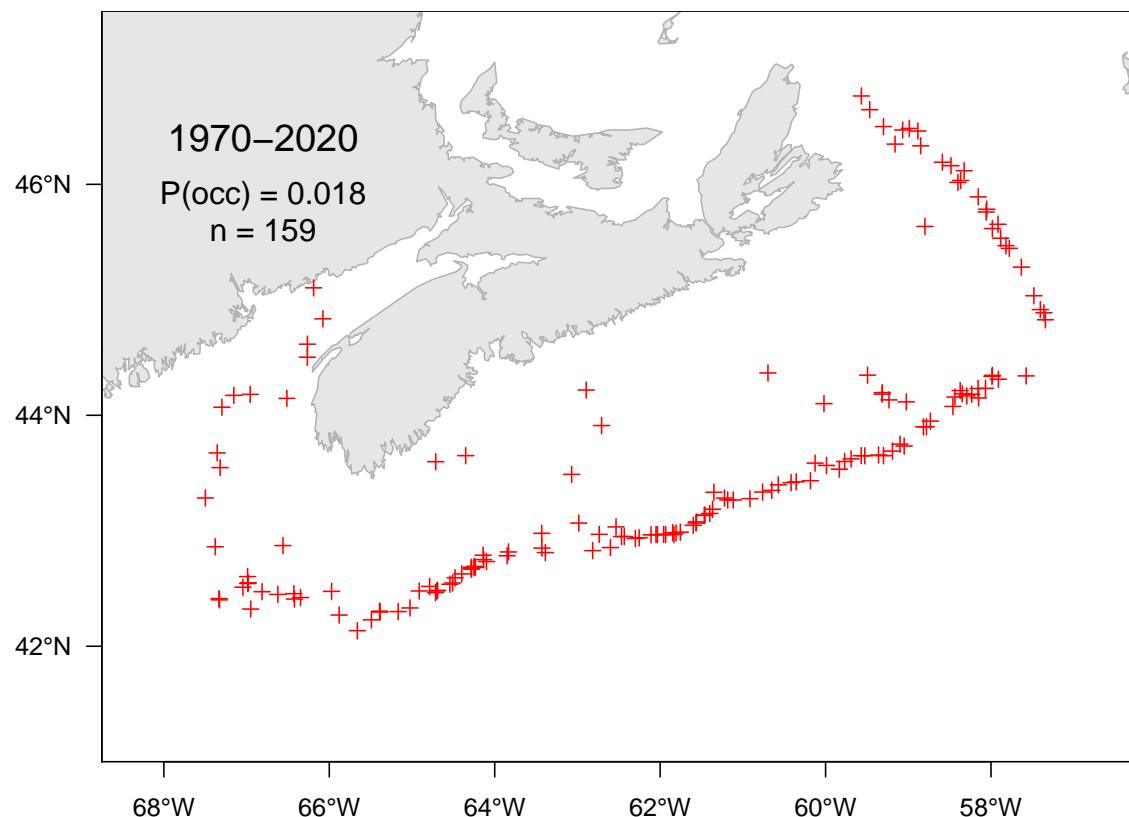


Figure 7.69A. Catch distribution for Lanternfishes.

1073

7.70 Shortnose greeneye (Éperlan du large) - species code 156 (category LR)

1074

Scientific name: [Chlorophthalmus agassizi](#)

1075

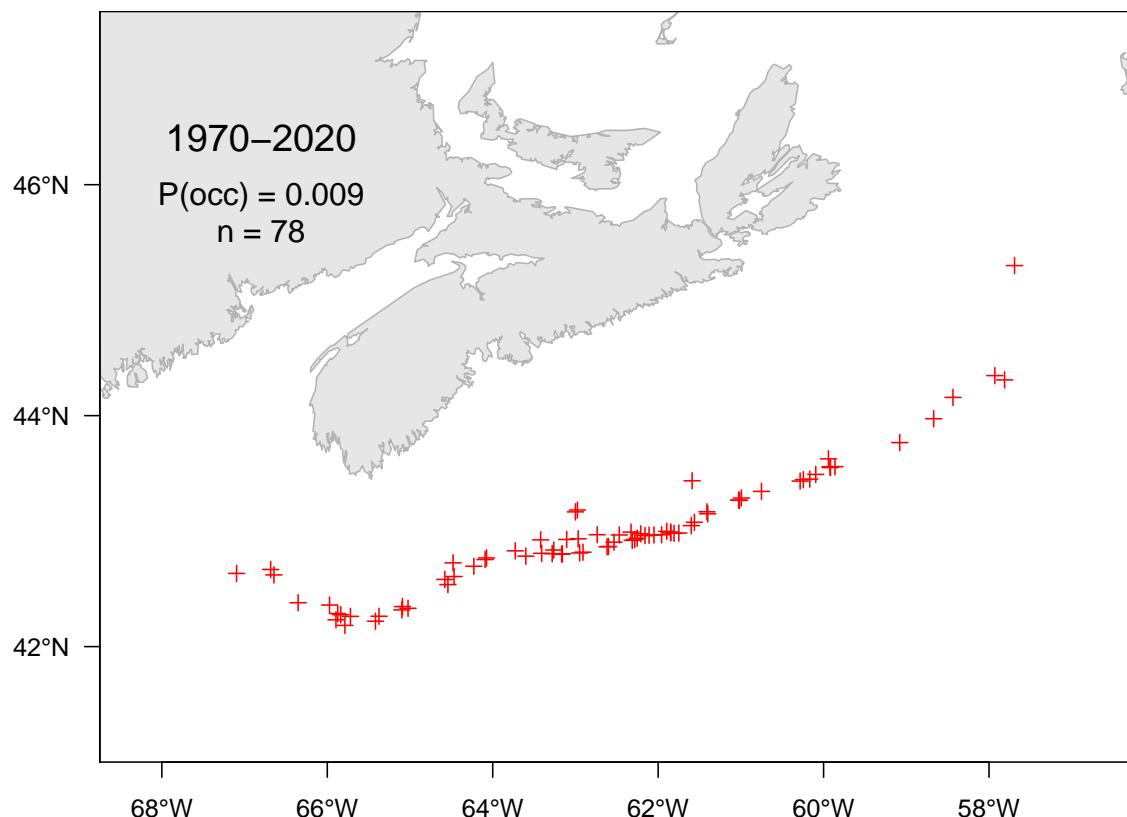


Figure 7.70A. Catch distribution for Shortnose greeneye.

1076

7.71 Silvery lightfish (Brossé améthyste) - species code 158 (category LR)

1077

Scientific name: [Maurolicus muelleri](#)

1078

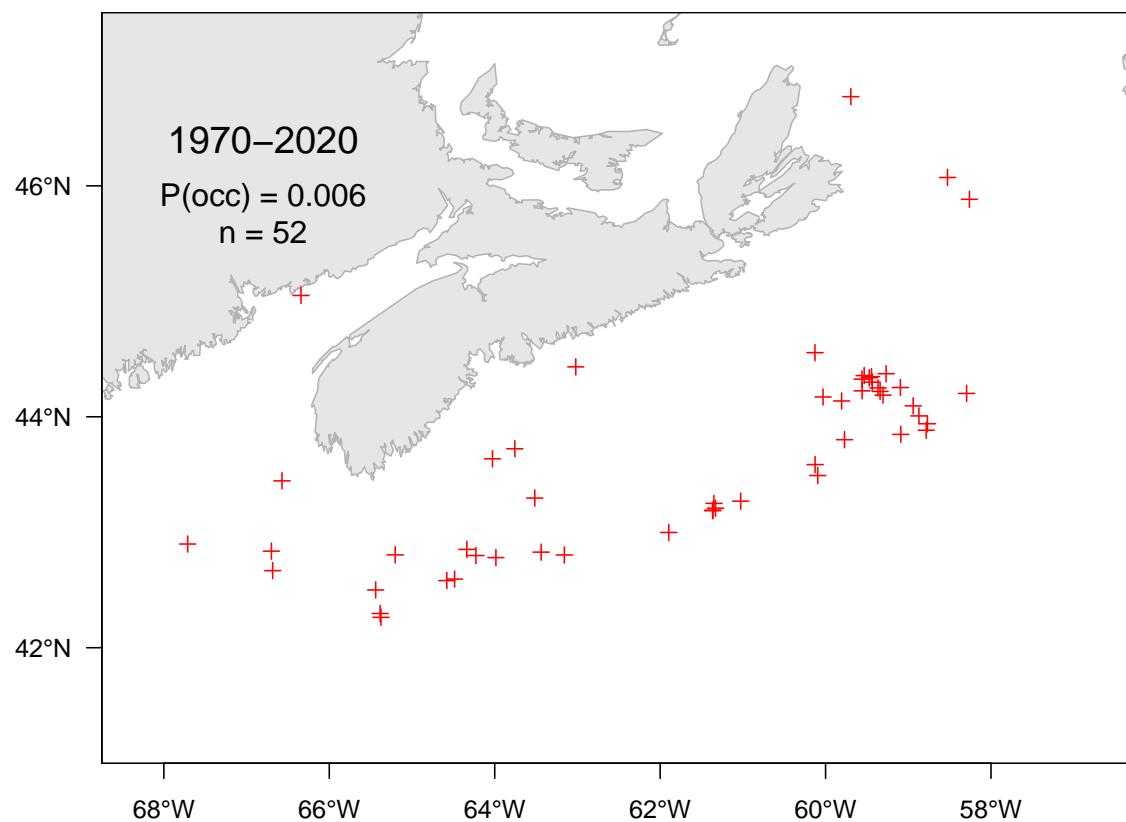


Figure 7.71A. Catch distribution for Silvery lightfish.

1079

7.72 Boa dragonfish (Dragon-boa) - species code 159 (category LR)

1080

Scientific name: [Stomias boa](#)

1081

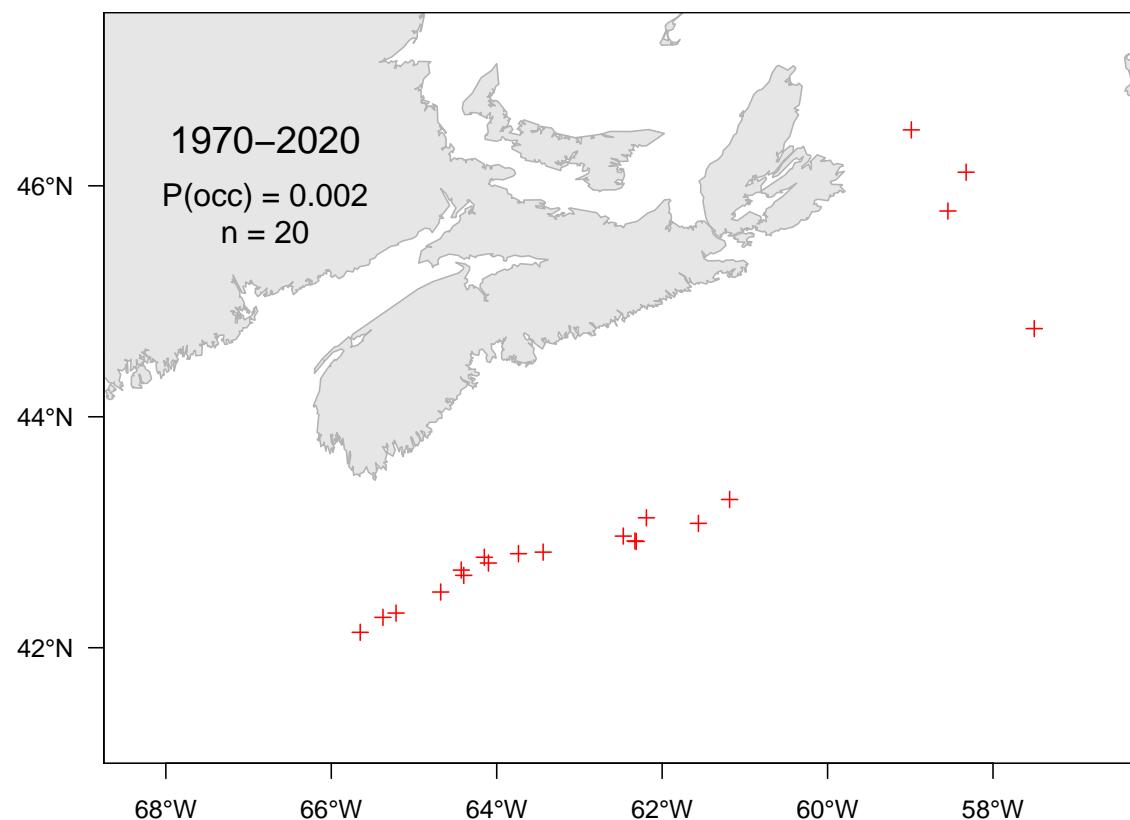


Figure 7.72A. Catch distribution for Boa dragonfish.

1082 **7.73 Shorthorn sculpin (Chabosseau à épines courtes) - species code 301 (category**
1083 **LR)**

1084 Scientific name: [Myoxocephalus scorpius](#)

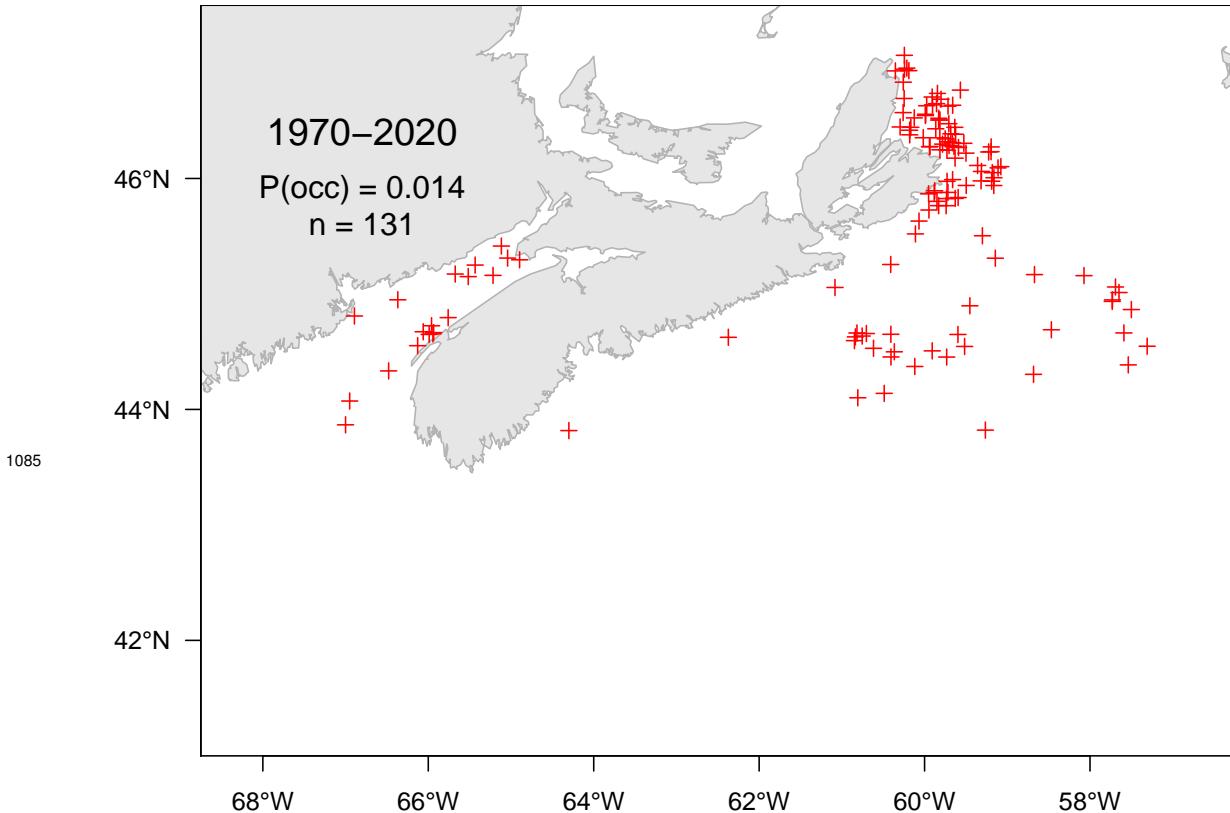


Figure 7.73A. Catch distribution for Shorthorn sculpin.

1086

7.74 Grubby (Chabosseau bronzé) - species code 303 (category LR)

1087

Scientific name: [Myoxocephalus aenaeus](#)

1088

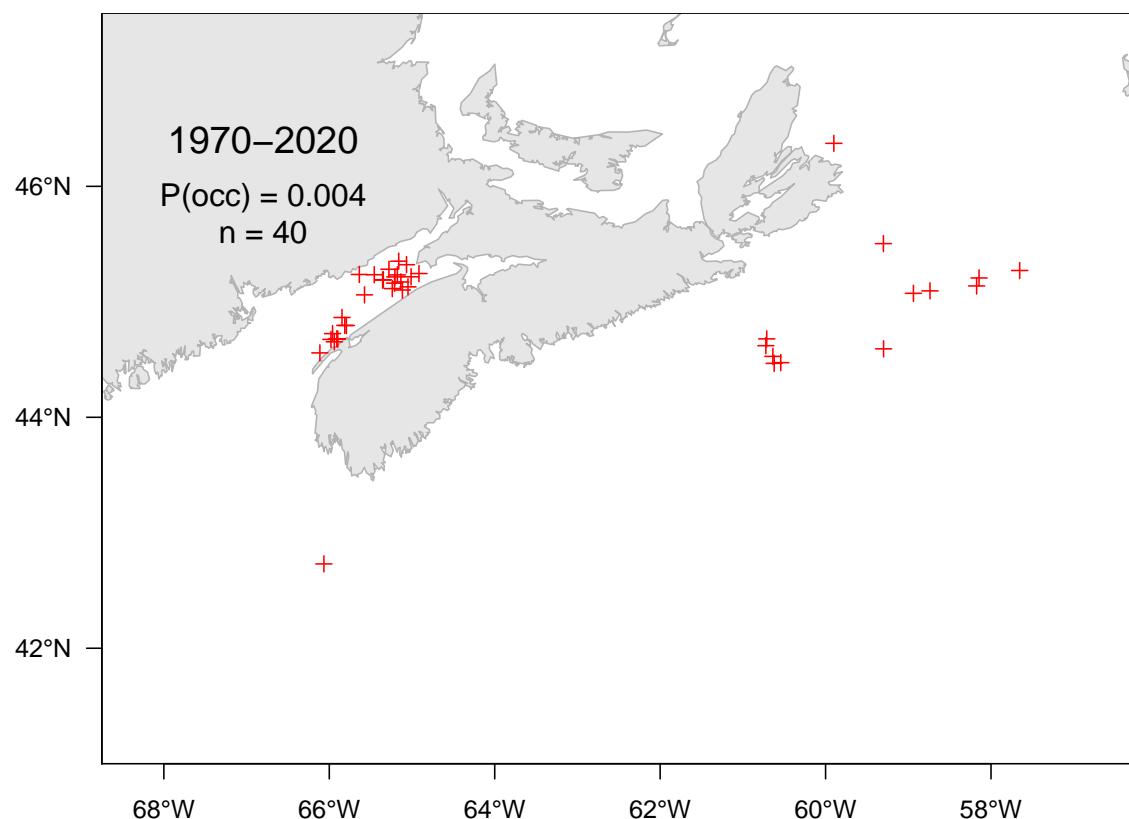


Figure 7.74A. Catch distribution for Grubby.

1089

7.75 Polar sculpin (Cotte polaire) - species code 307 (category LR)

1090

Scientific name: [Cottunculus microps](#)

1091

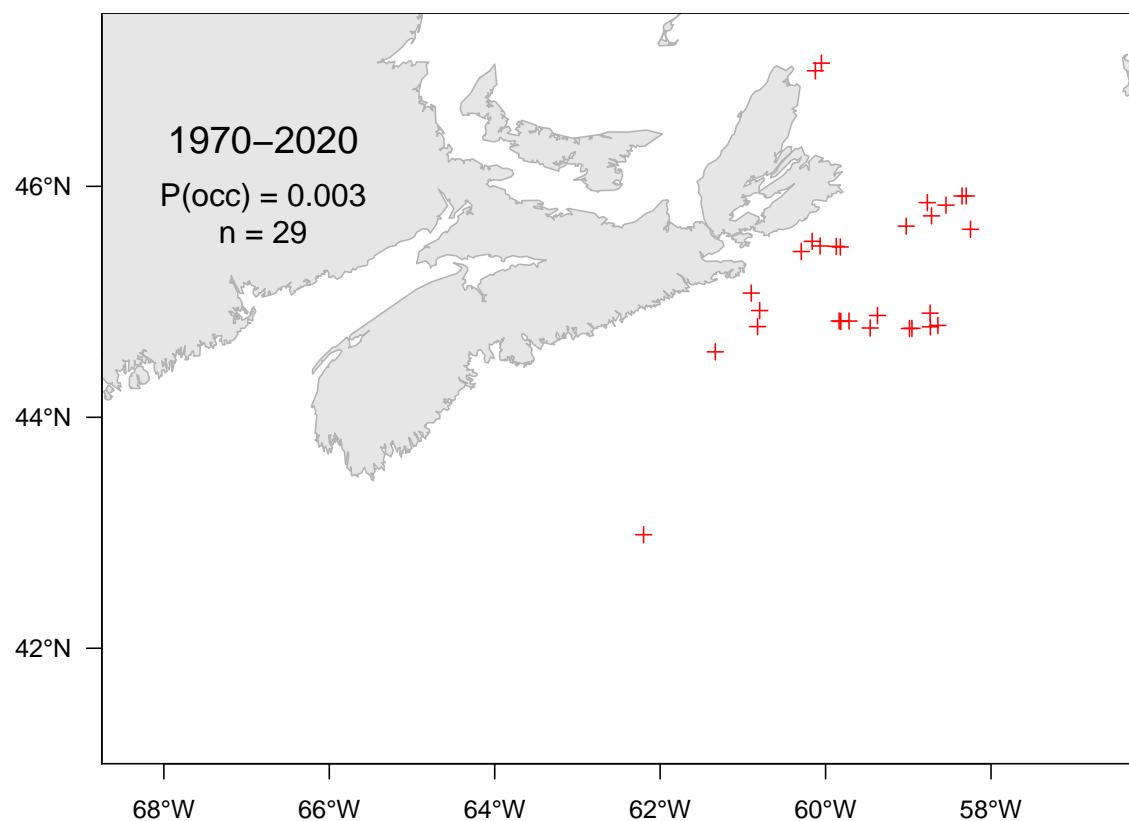


Figure 7.75A. Catch distribution for Polar sculpin.

1092

7.76 Spatulate sculpin (Icèle spatulée) - species code 314 (category LR)

1093

Scientific name: *Icelus spatula*

1094

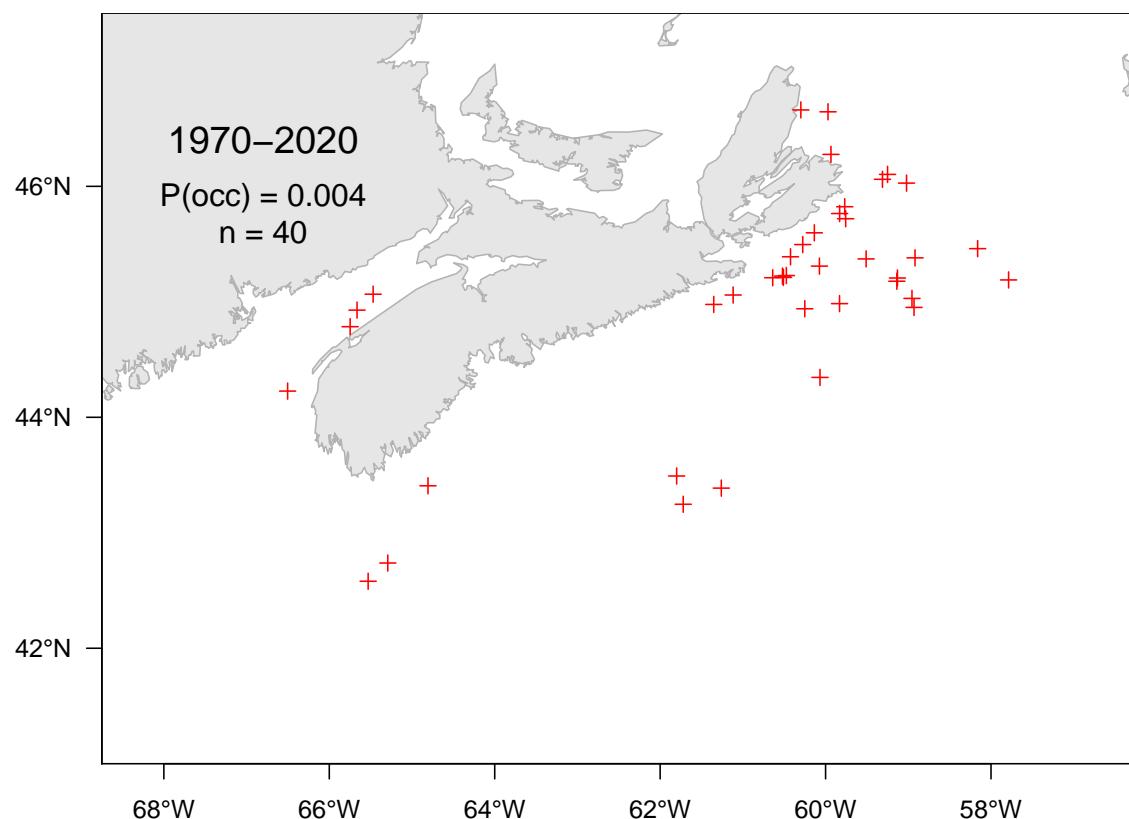


Figure 7.76A. Catch distribution for Spatulate sculpin.

1095

7.77 Arctic alligatorfish (Poisson-alligator arctique) - species code 341 (category LR)

1096

Scientific name: [Ulcina olrikii](#)

1097

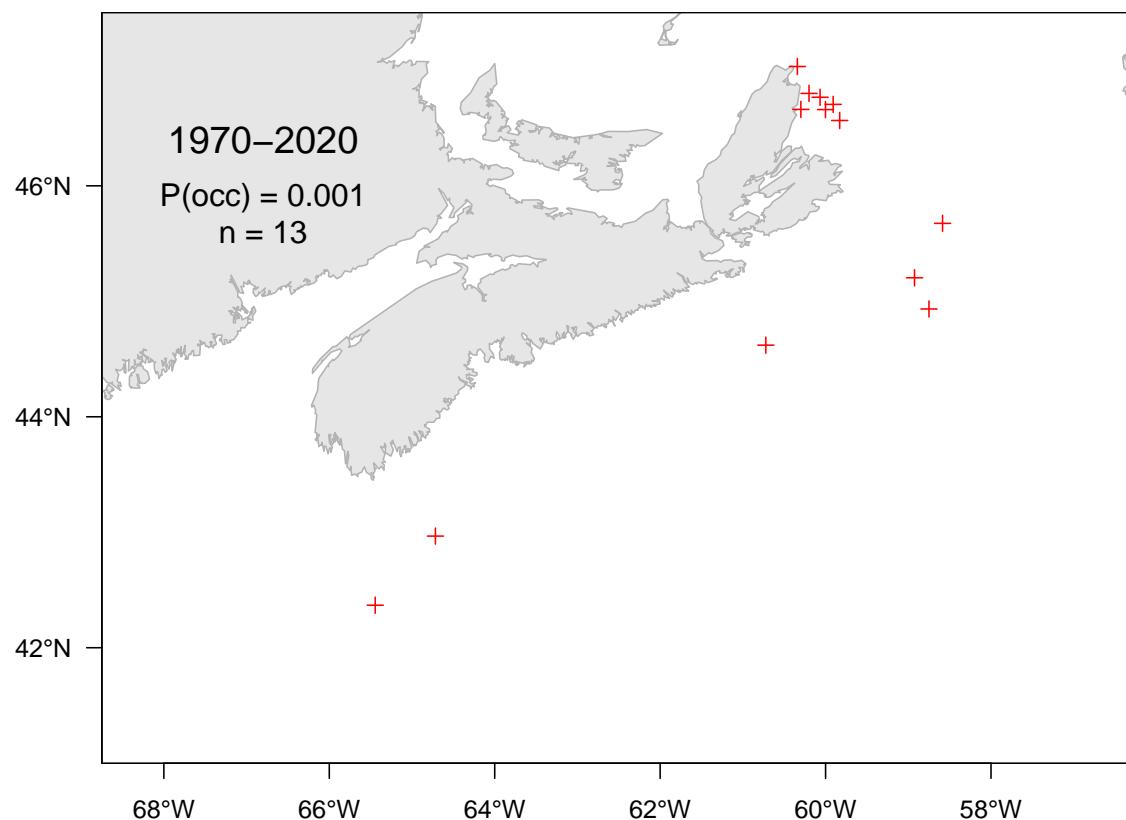


Figure 7.77A. Catch distribution for Arctic alligatorfish.

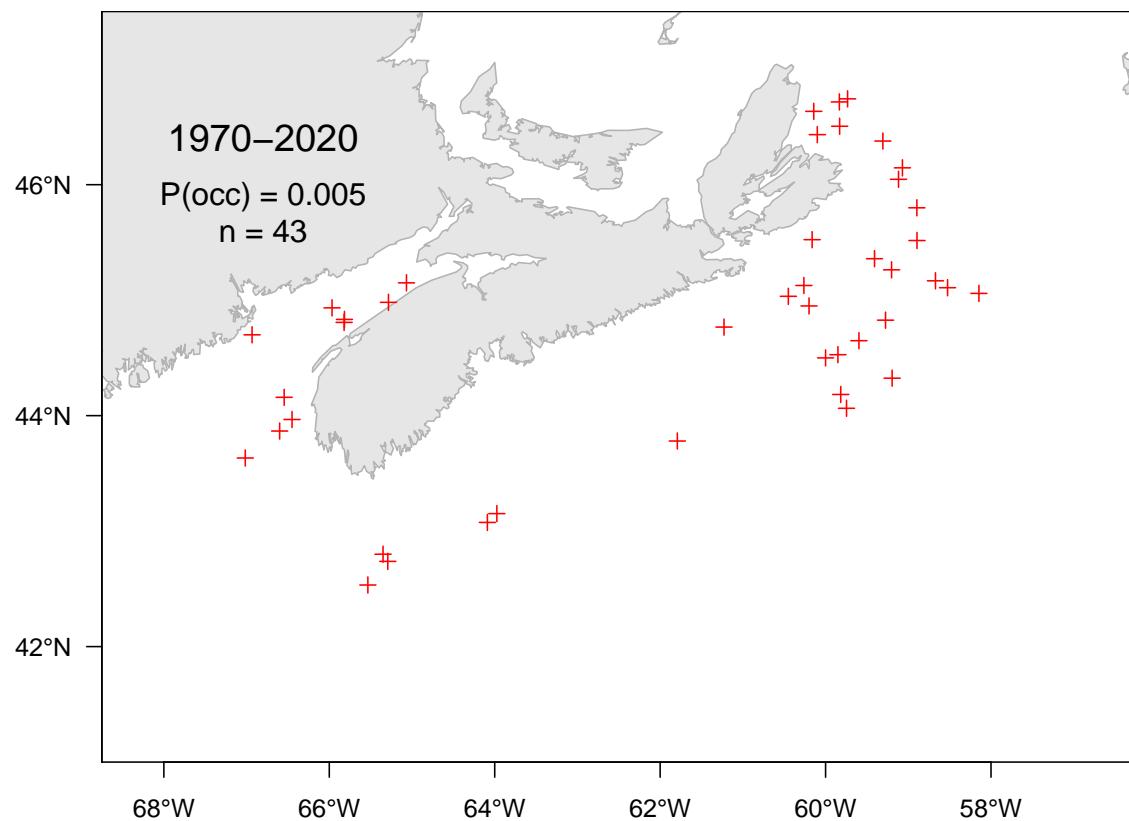
1098

7.78 Alligatorfishes (Poissons-alligator) - species code 351 (category LR)

1099

Scientific name: [Agonidae](#)

1100



1101 **7.79 Roughnose grenadier (Grenadier-scie) - species code 412 (category LR)**

1102 Scientific name: [Trachyrincus murrayi](#)

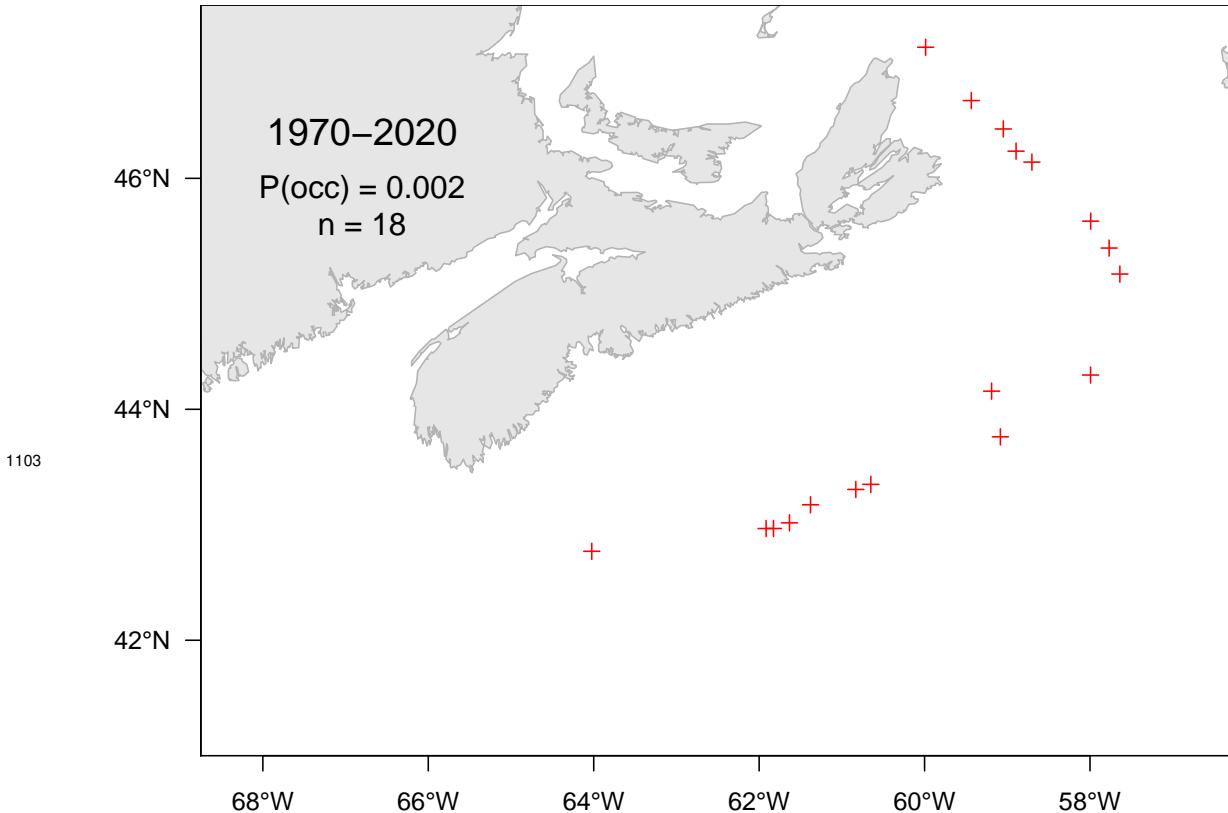


Figure 7.79A. Catch distribution for Roughnose grenadier.

1104

7.80 Roundnose grenadier (Grenadier de roche) - species code 414 (category LR)

1105

Scientific name: [Coryphaenoides rupestris](#)

1106

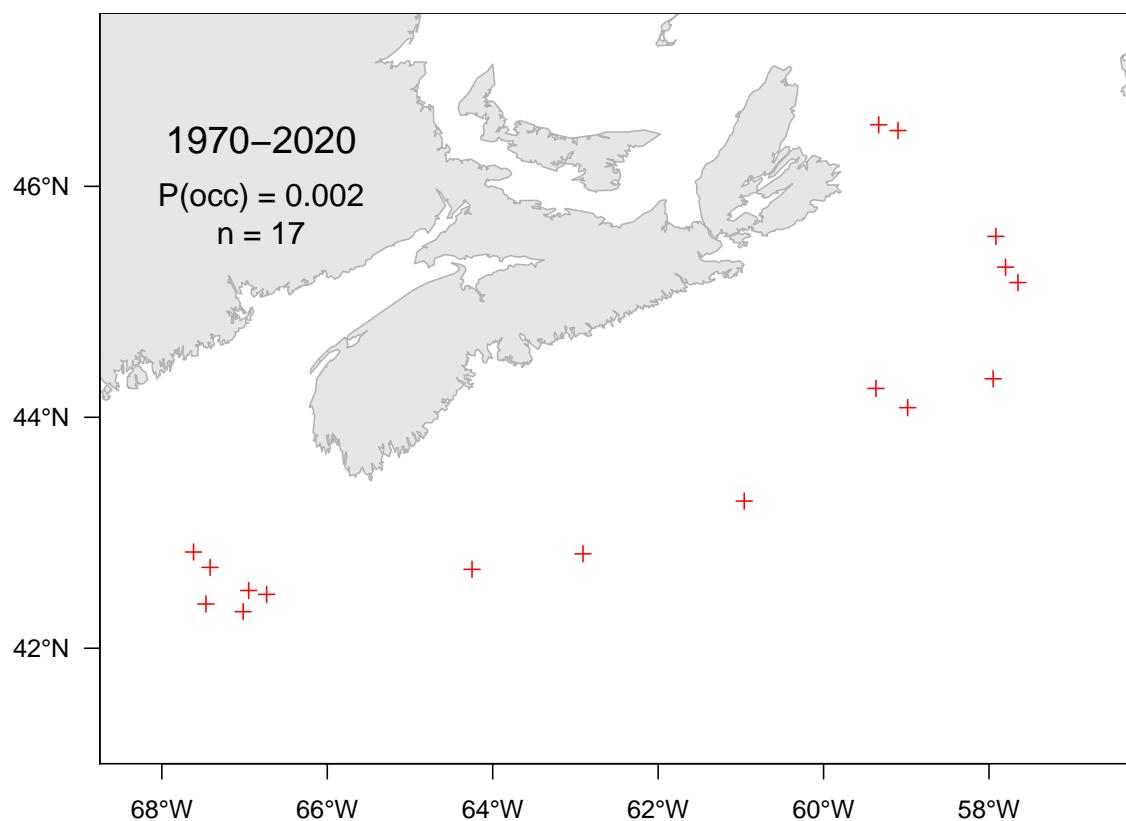


Figure 7.80A. Catch distribution for Roundnose grenadier.

1107 **7.81 Atlantic seasnail (*Limace atlantique*) - species code 503 (category LR)**

1108 Scientific name: [Liparis atlanticus](#)

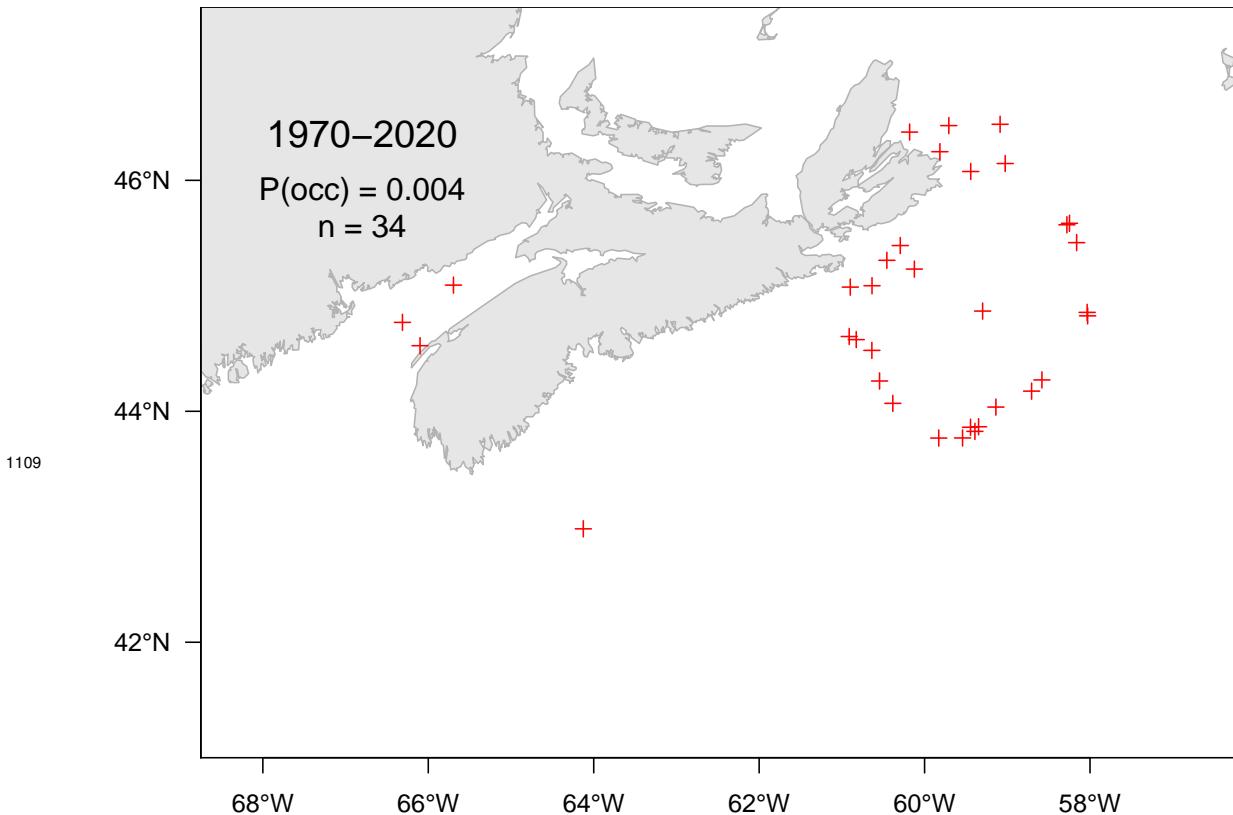


Figure 7.81A. Catch distribution for Atlantic seasnail.

1110 **7.82 Gelatinous snailfish (Limace gélatineuse) - species code 505 (category LR)**

1111 Scientific name: [Liparis fabricii](#)

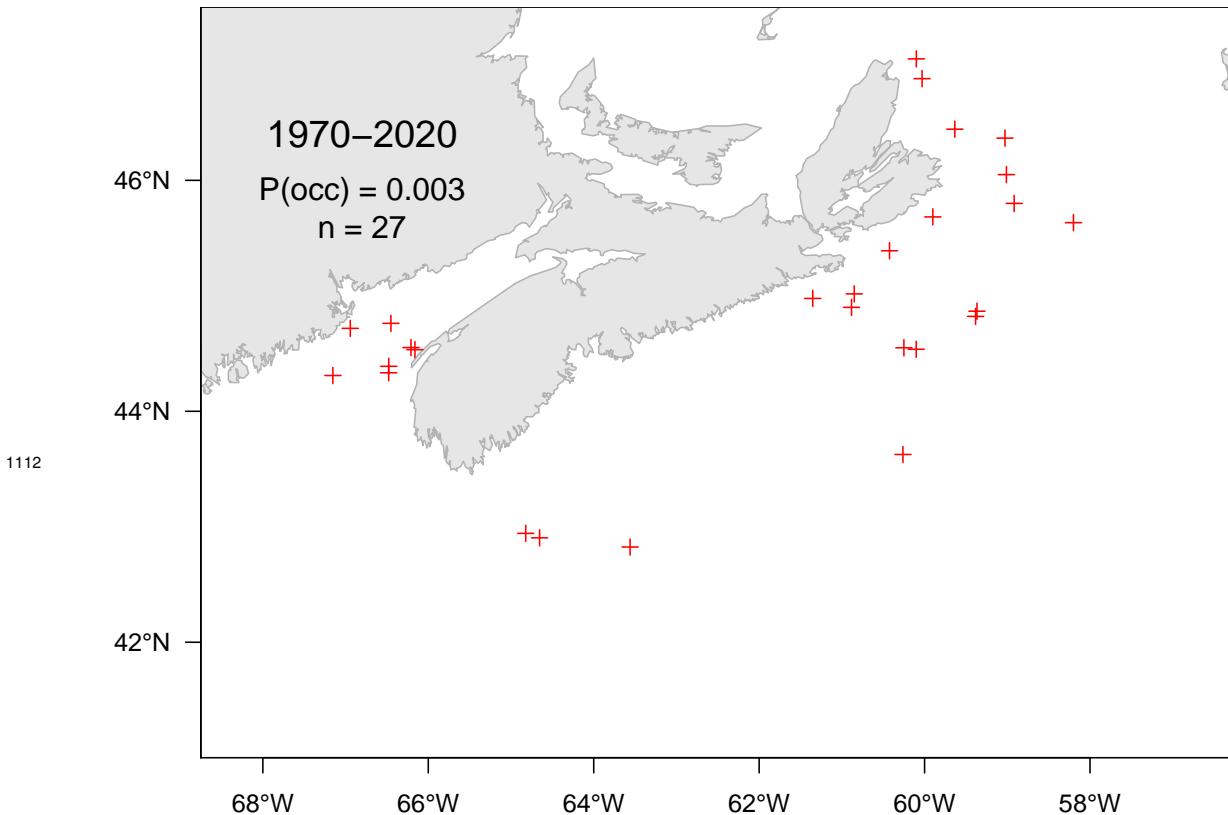


Figure 7.82A. Catch distribution for Gelatinous snailfish.

1113

7.83 Variegated snailfish (*Limace marbée*) - species code 512 (category LR)

1114

Scientific name: [Liparis gibbus](#)

1115

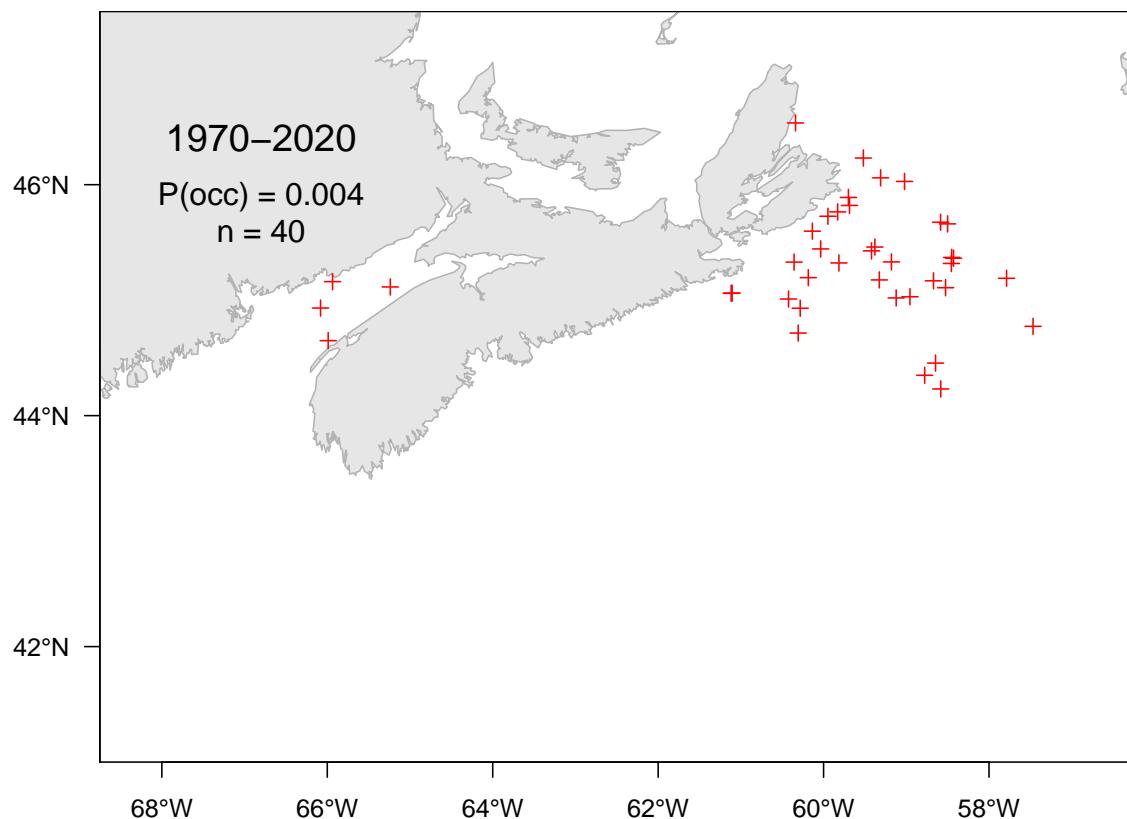


Figure 7.83A. Catch distribution for Variegated snailfish.

1116

7.84 Sea tadpole (Petite limace de mer) - species code 520 (category LR)

1117

Scientific name: [Careproctus reinhardtii](#)

1118

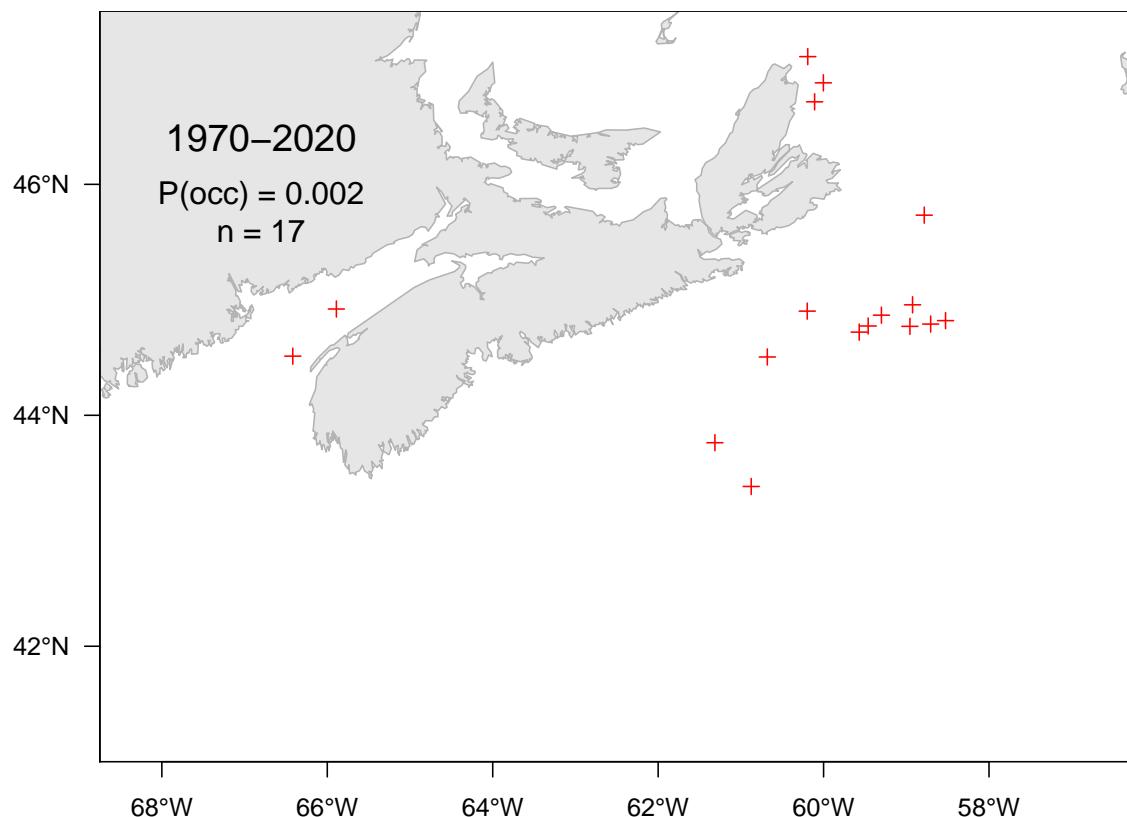


Figure 7.84A. Catch distribution for Sea tadpole.

1119

7.85 Wolf eelpout (*Lycodes à tête longue*) - species code 603 (category LR)

1120

Scientific name: [Lycenchelys verrillii](#)

1121

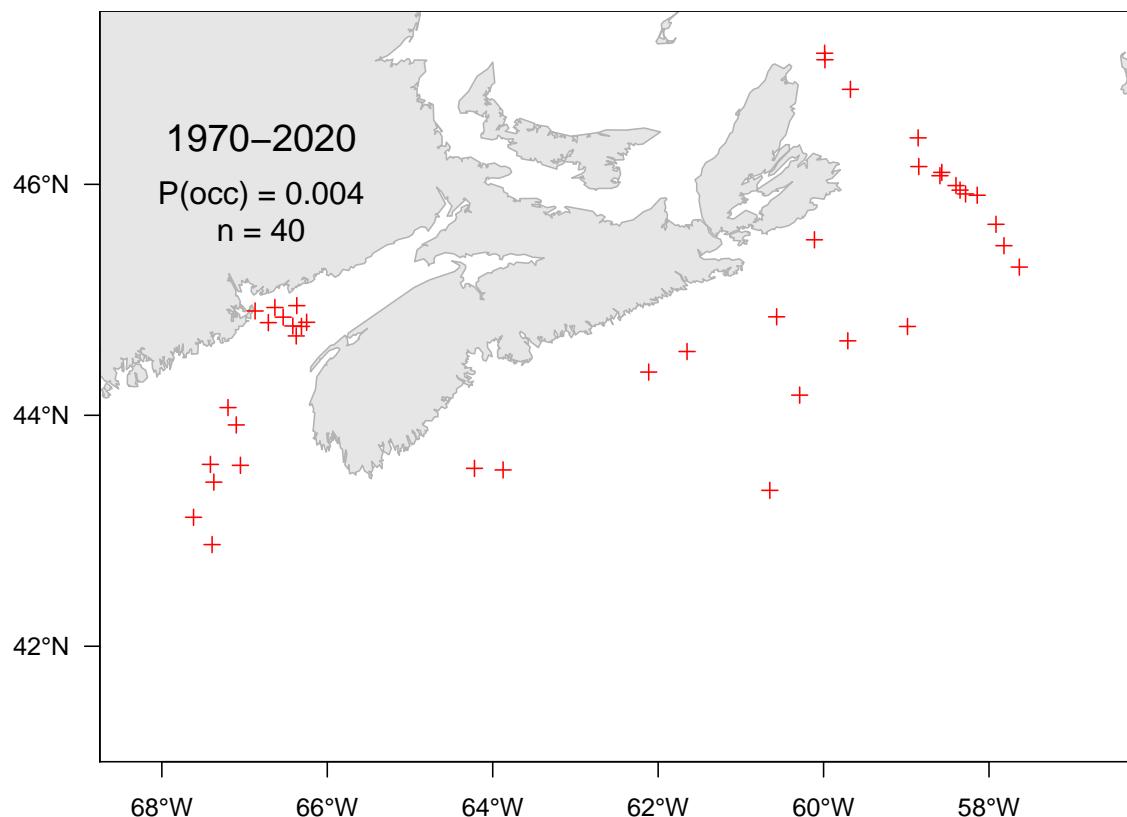


Figure 7.85A. Catch distribution for Wolf eelpout.

1122

7.86 Slender snipe eel (*Avocette ruban*) - species code 604 (category LR)

1123

Scientific name: [Nemichthys scolopaceus](#)

1124

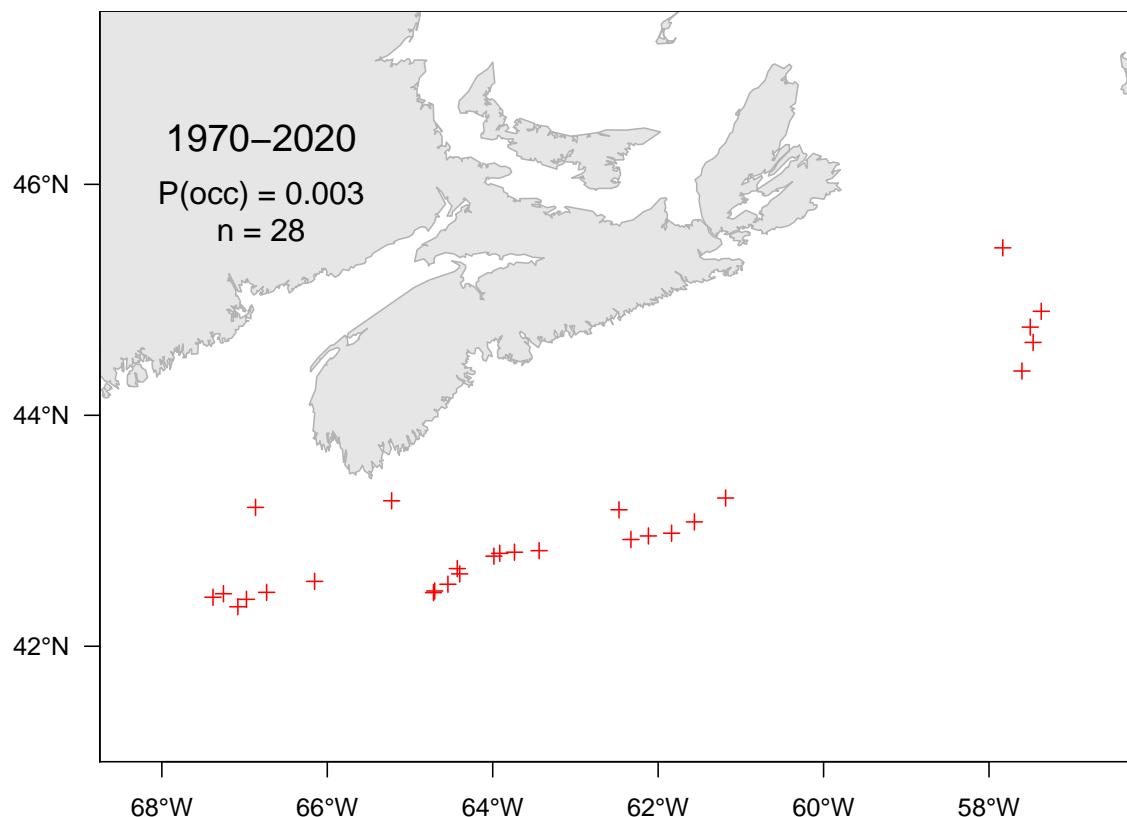


Figure 7.86A. Catch distribution for Slender snipe eel.

1125 **7.87 Newfoundland eelpout (Lycodes du Labrador) - species code 619 (category LR)**

1126 Scientific name: [Lycodes terraenovae](#)

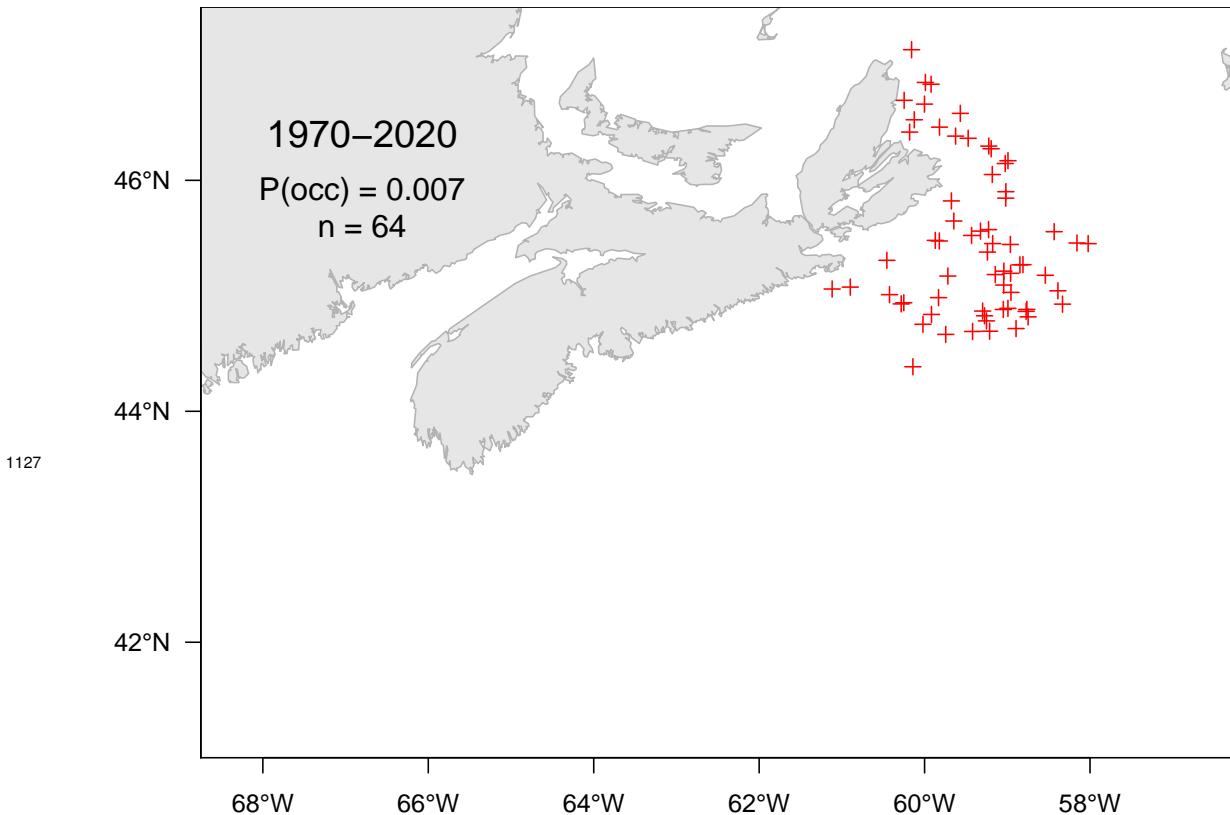


Figure 7.87A. Catch distribution for Newfoundland eelpout.

1128

7.88 Newfoundland eelpout (*Lycodes lavalaei*) - species code 620 (category LR)

1129

Scientific name: [Lycodes lavalaei](#)

1130

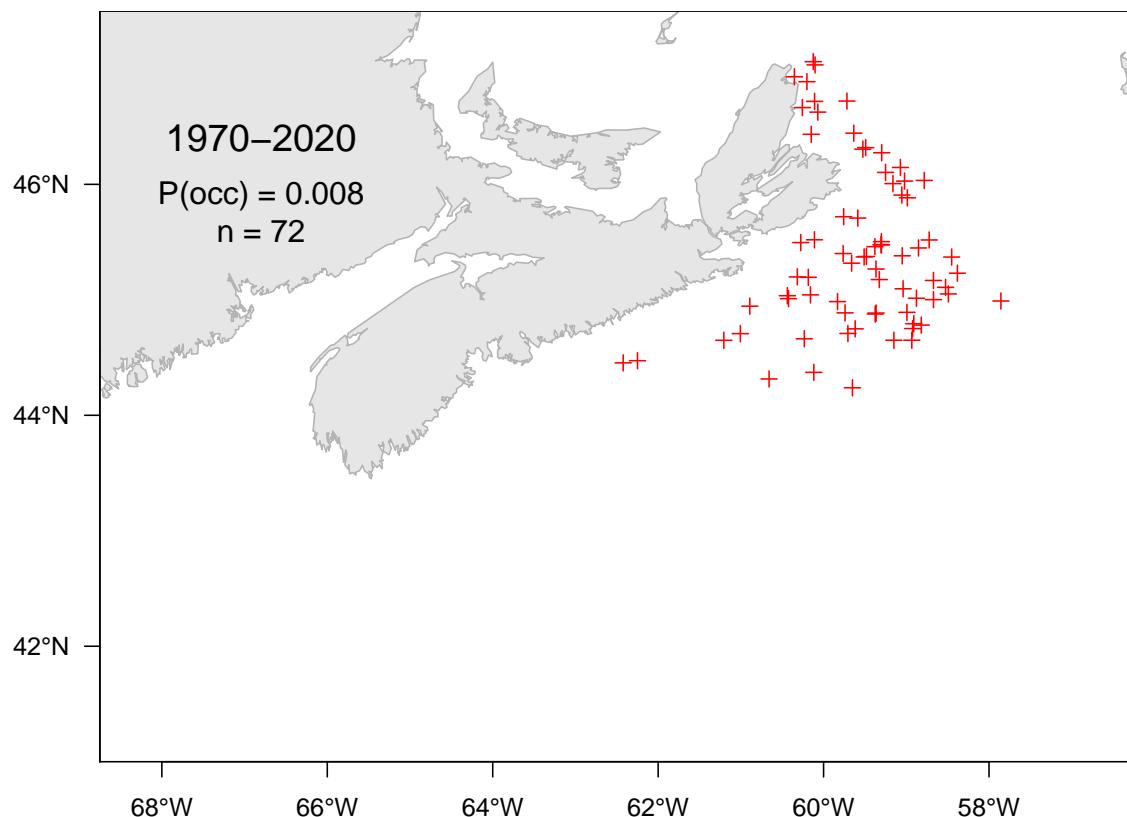


Figure 7.88A. Catch distribution for Newfoundland eelpout.

1131

7.89 Rock gunnel (Sigouine de roche) - species code 621 (category LR)

1132

Scientific name: [Pholis gunnellus](#)

1133

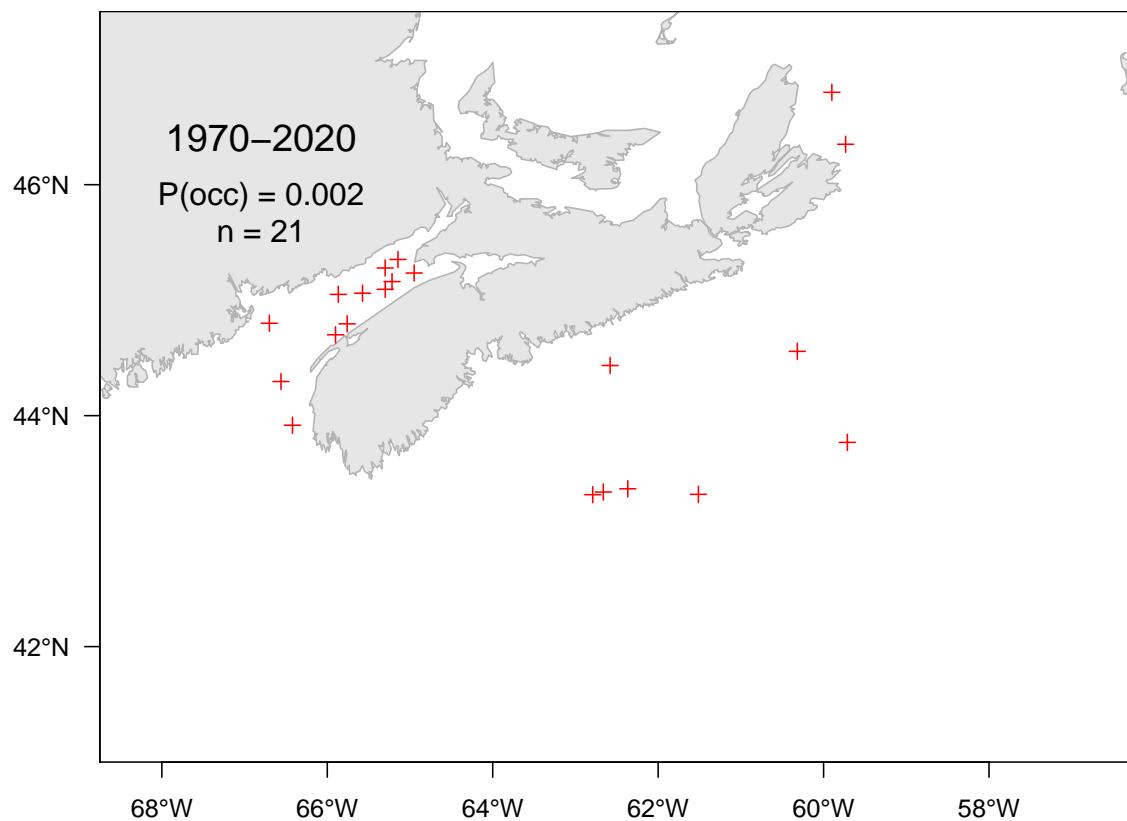


Figure 7.89A. Catch distribution for Rock gunnel.

1134

7.90 Radiated shanny (*Ulvaria deux-lignes*) - species code 625 (category LR)

1135

Scientific name: [Ulvaria subbifurcata](#)

1136

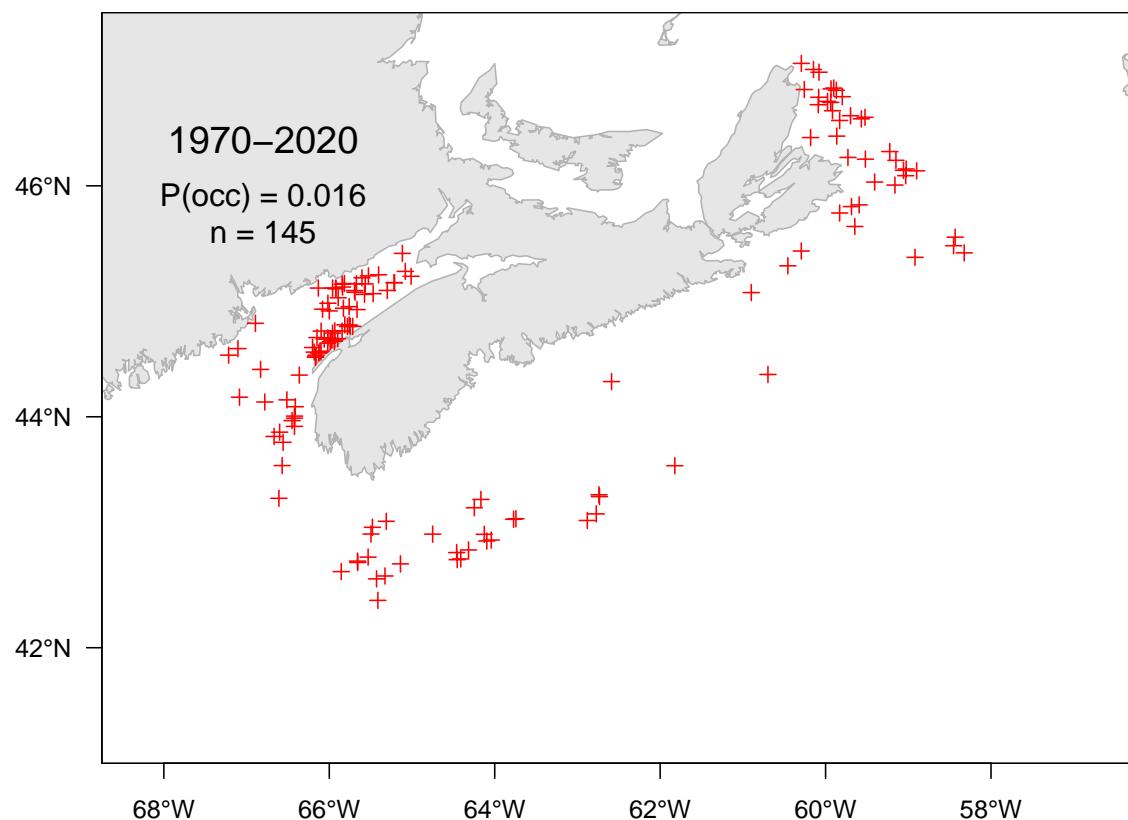


Figure 7.90A. Catch distribution for Radiated shanny.

1137

7.91 Fourline snakeblenny (Quatre-lignes atlantique) - species code 626 (category LR)

1138

Scientific name: [Eumesogrammus praecisus](#)

1139

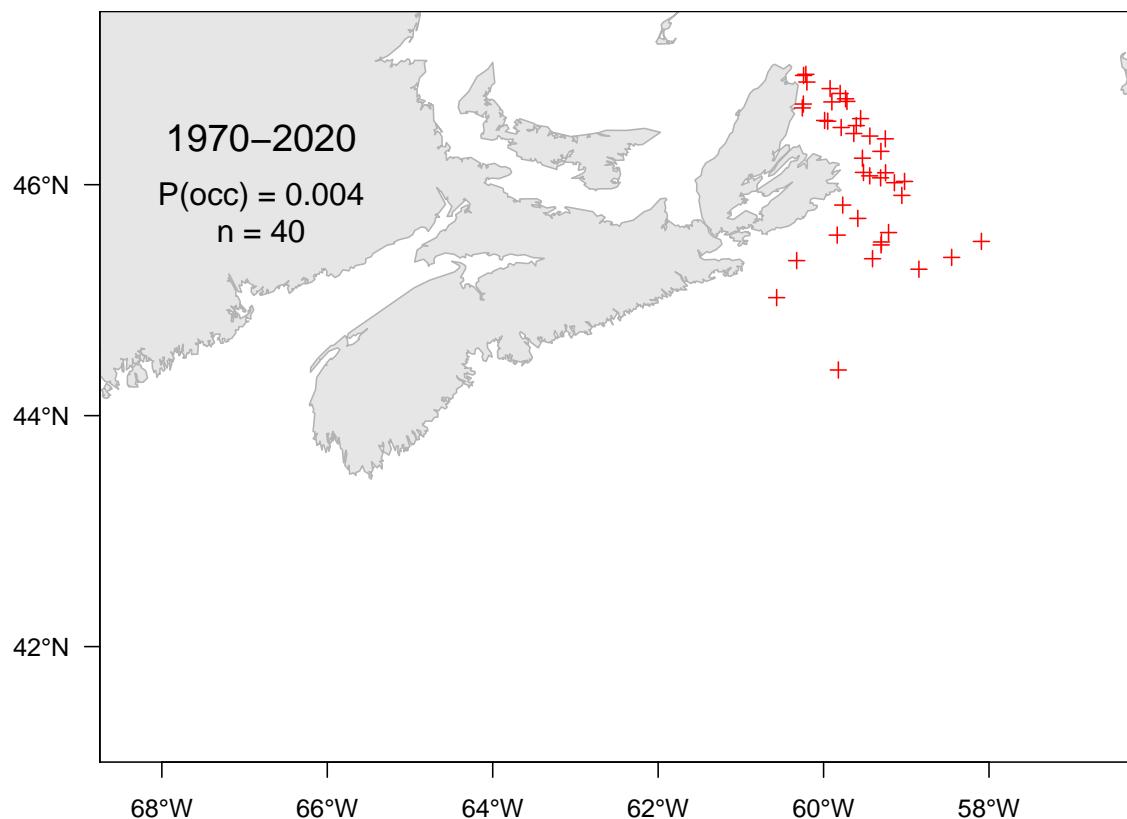


Figure 7.91A. Catch distribution for Fourline snakeblenny.

1140

7.92 Wrymouth (Terrassier tacheté) - species code 630 (category LR)

1141

Scientific name: [Cryptacanthodes maculatus](#)

1142

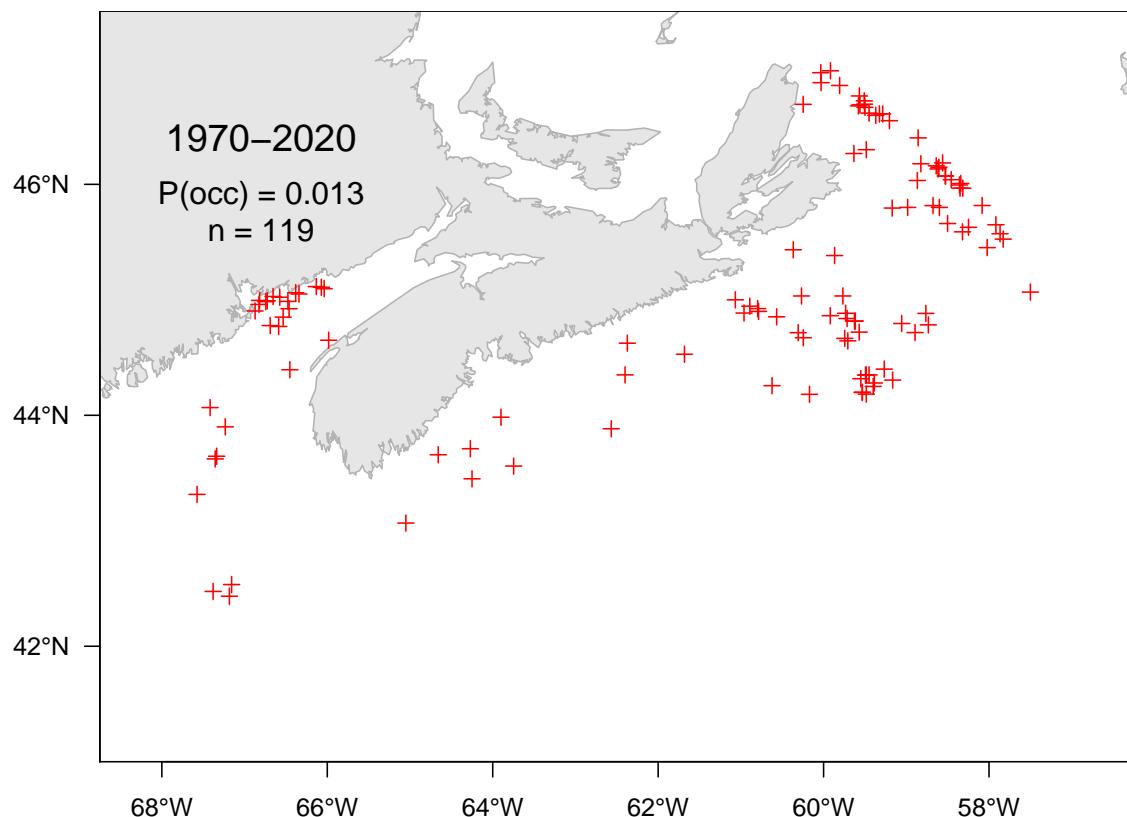


Figure 7.92A. Catch distribution for Wrymouth.

1143

7.93 Spotfin dragonet (Dragonnet tacheté) - species code 637 (category LR)

1144

Scientific name: [Foetorepus agassizii](#)

1145

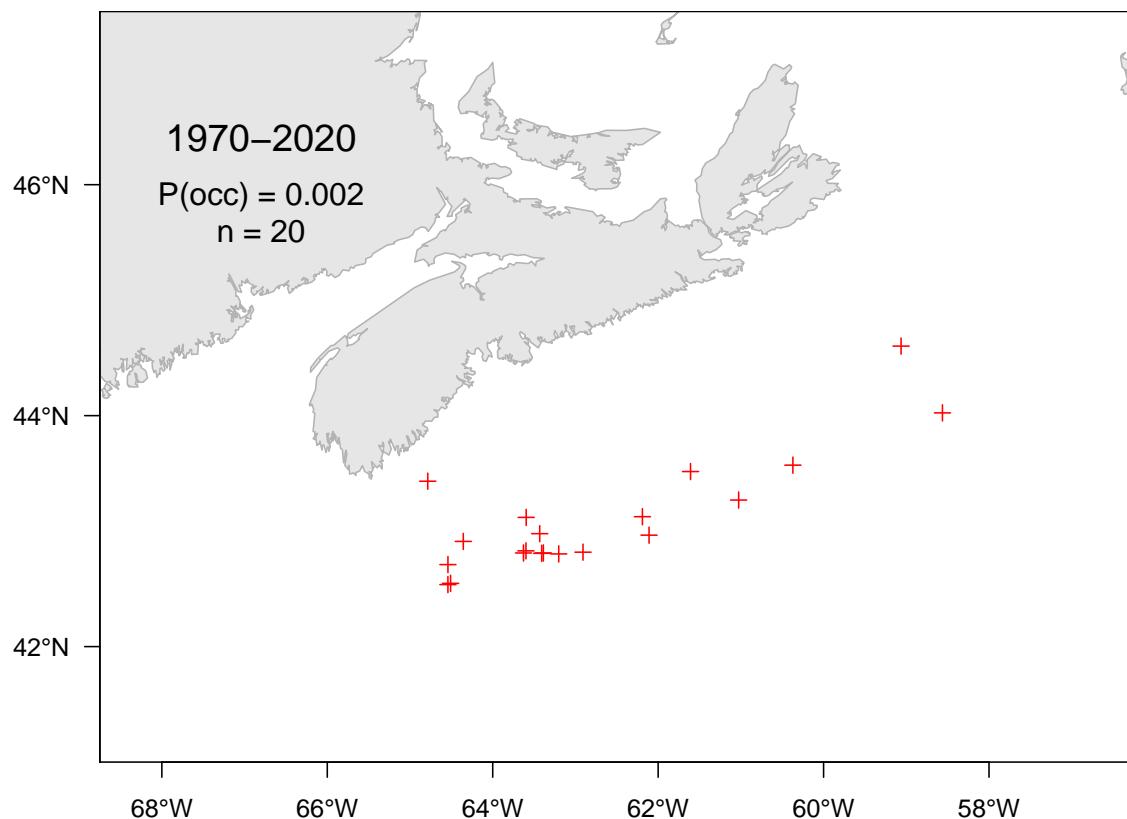


Figure 7.93A. Catch distribution for Spotfin dragonet.

1146

7.94 Arctic eelpout (*Lycodes arctique*) - species code 641 (category LR)

1147

Scientific name: [Lycodes reticulatus](#)

1148

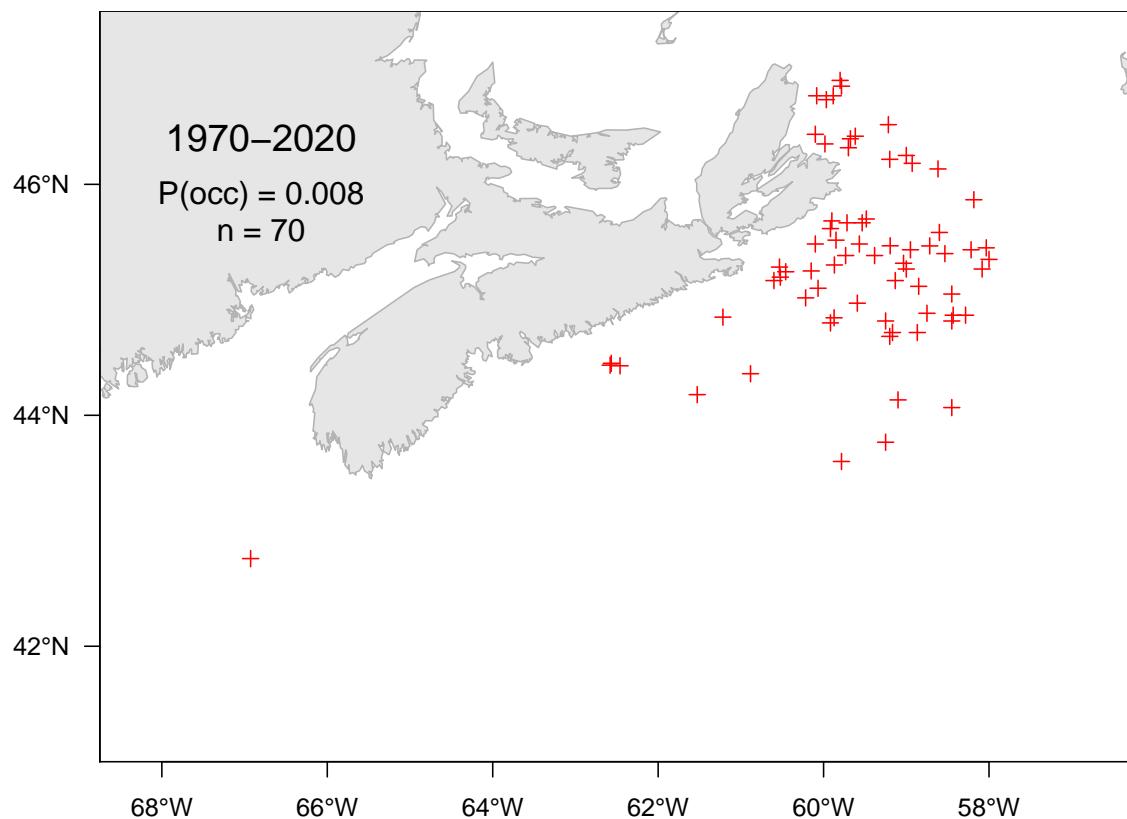


Figure 7.94A. Catch distribution for Arctic eelpout.

1149

7.95 Atlantic soft pout (*Molasse atlantique*) - species code 646 (category LR)

1150

Scientific name: [Melanostigma atlanticum](#)

1151

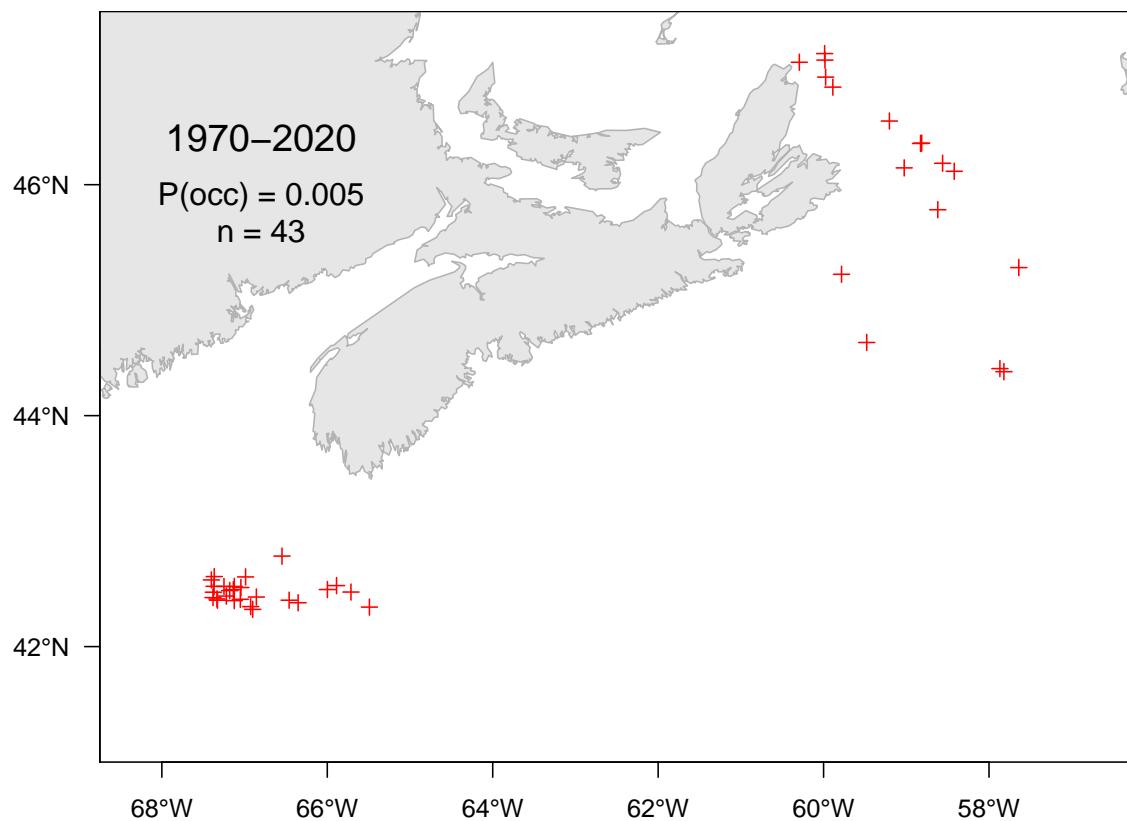


Figure 7.95A. Catch distribution for Atlantic soft pout.

1152

7.96 Silvery John dory (Saint Pierre argenté) - species code 704 (category LR)

1153

Scientific name: [Zenopsis conchifer](#)

1154

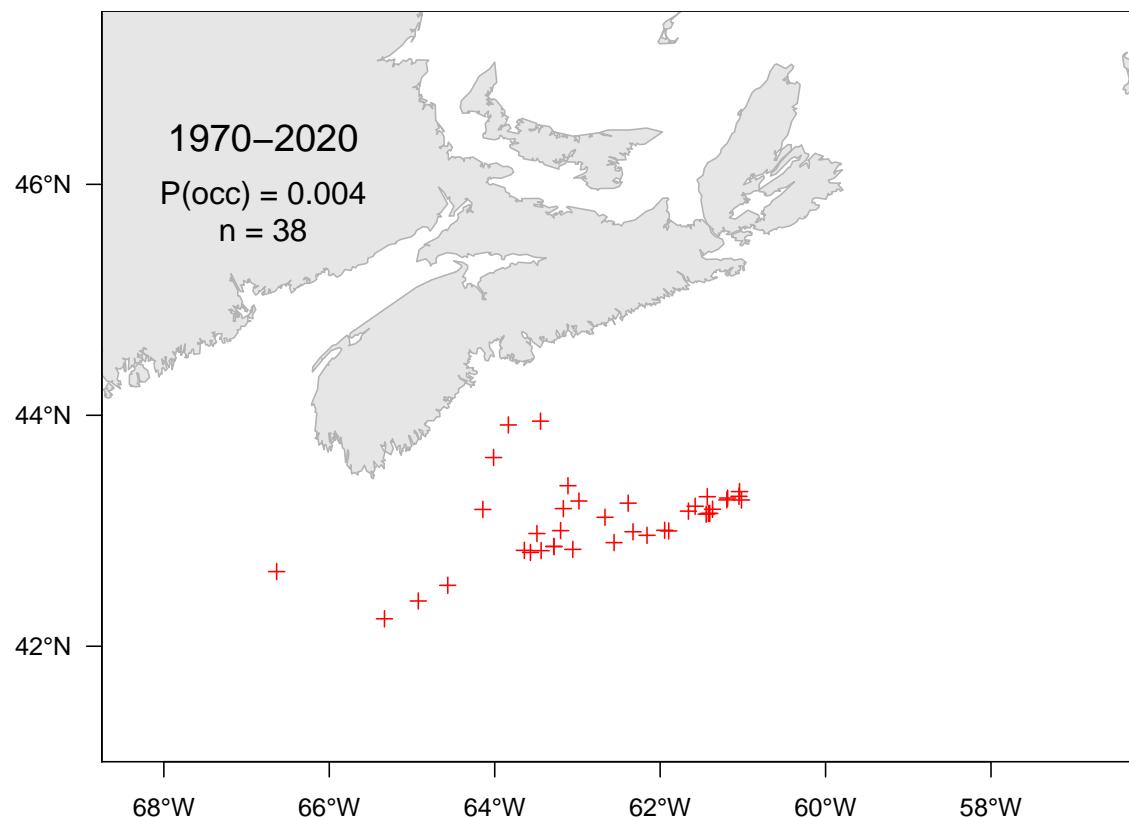


Figure 7.96A. Catch distribution for Silvery John dory.

1155

7.97 White barracudina (*Lussion blanc*) - species code 712 (category LR)

1156

Scientific name: [Arctozenus risso](#)

1157

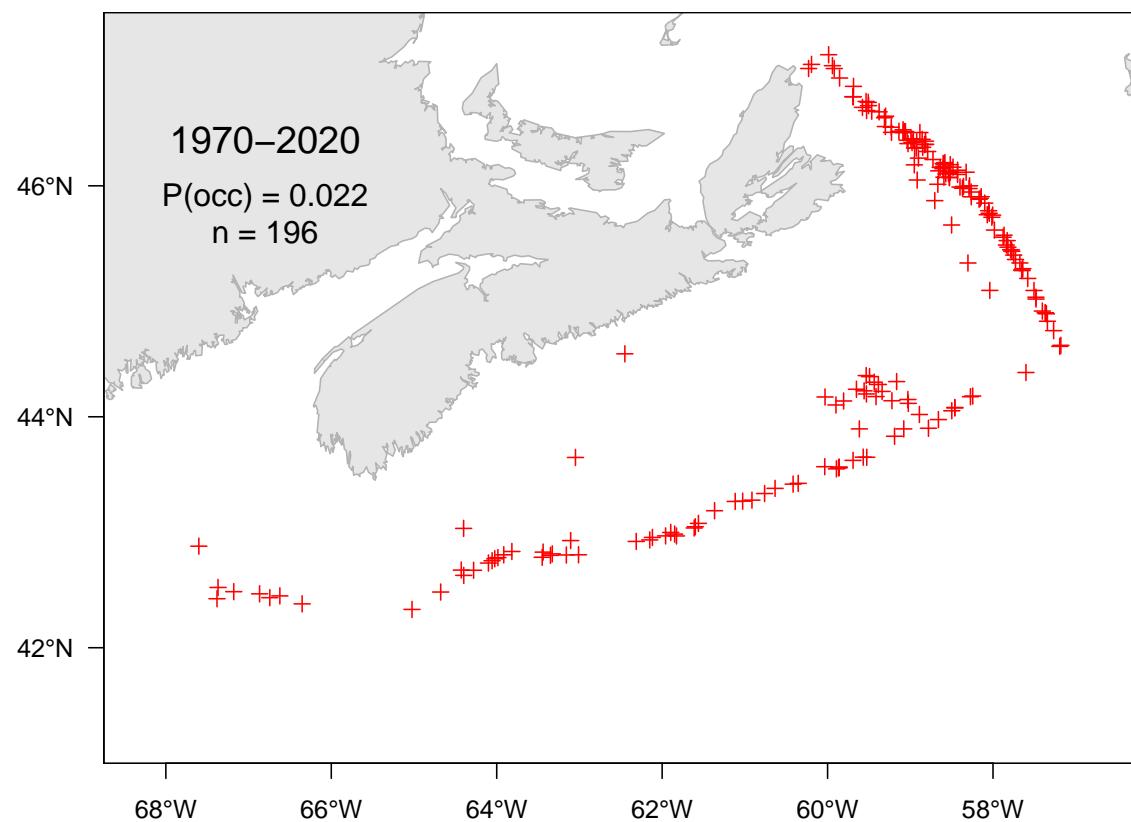


Figure 7.97A. Catch distribution for White barracudina.

1158

7.98 Atlantic saury (*Balaou atlantique*) - species code 720 (category LR)

1159

Scientific name: [Scomberesox saurus](#)

1160

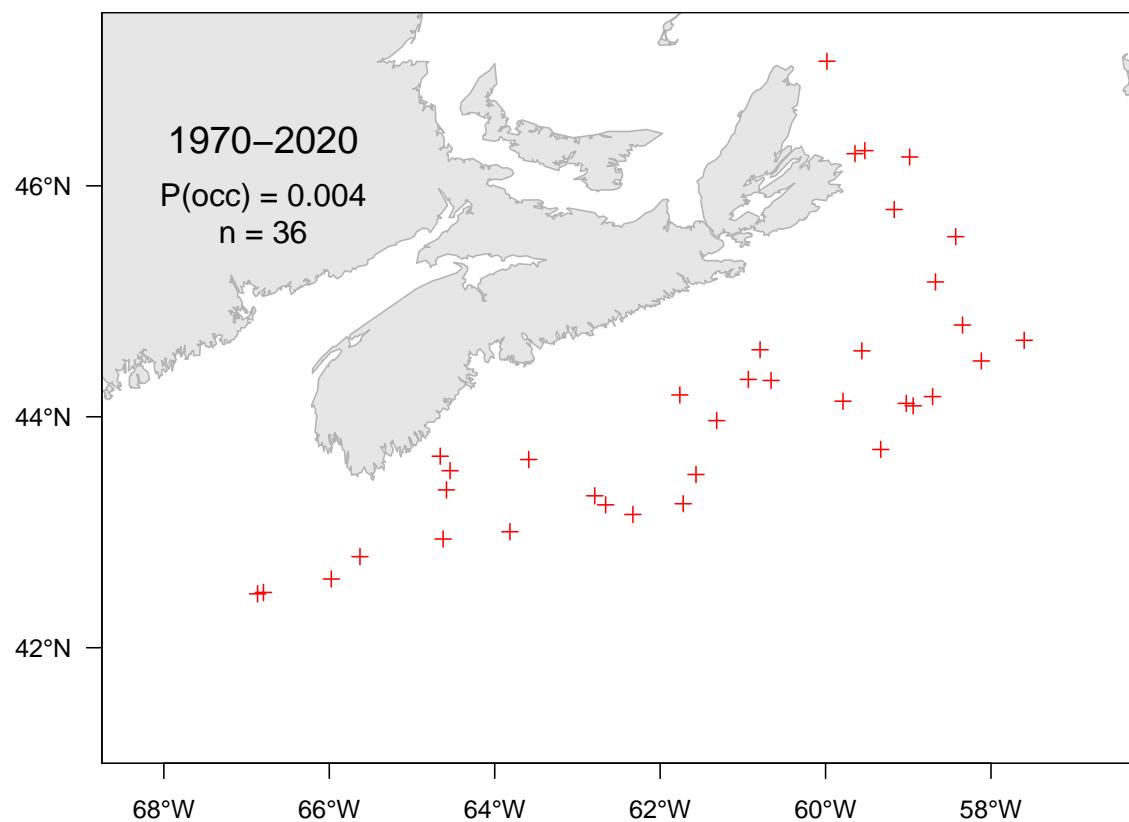


Figure 7.98A. Catch distribution for Atlantic saury.

1161

7.99 Hatchetfishes (Haches d'argent) - species code 741 (category LR)

1162

Scientific name: [Sternopychidae](#)

1163

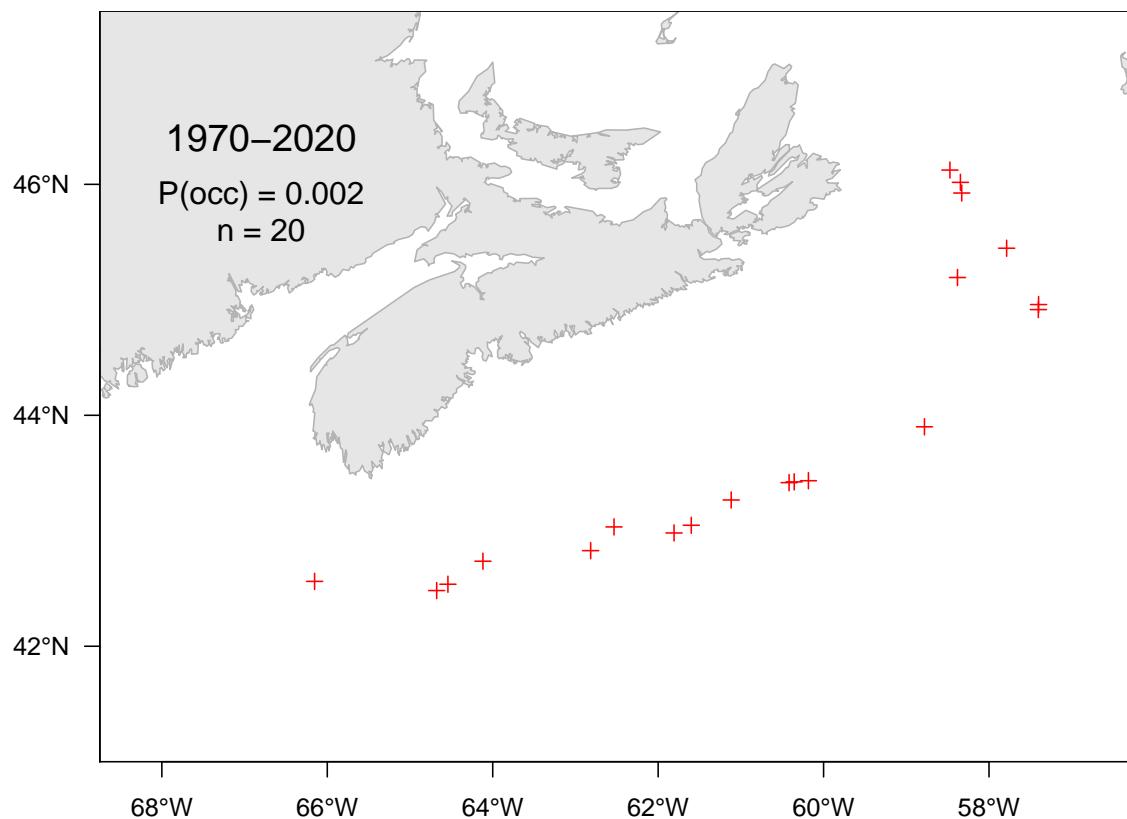


Figure 7.99A. Catch distribution for Hatchetfishes.

1164

7.100 Atlantic batfish (*Malthe atlantique*) - species code 742 (category LR)

1165

Scientific name: [Dibranchus atlanticus](#)

1166

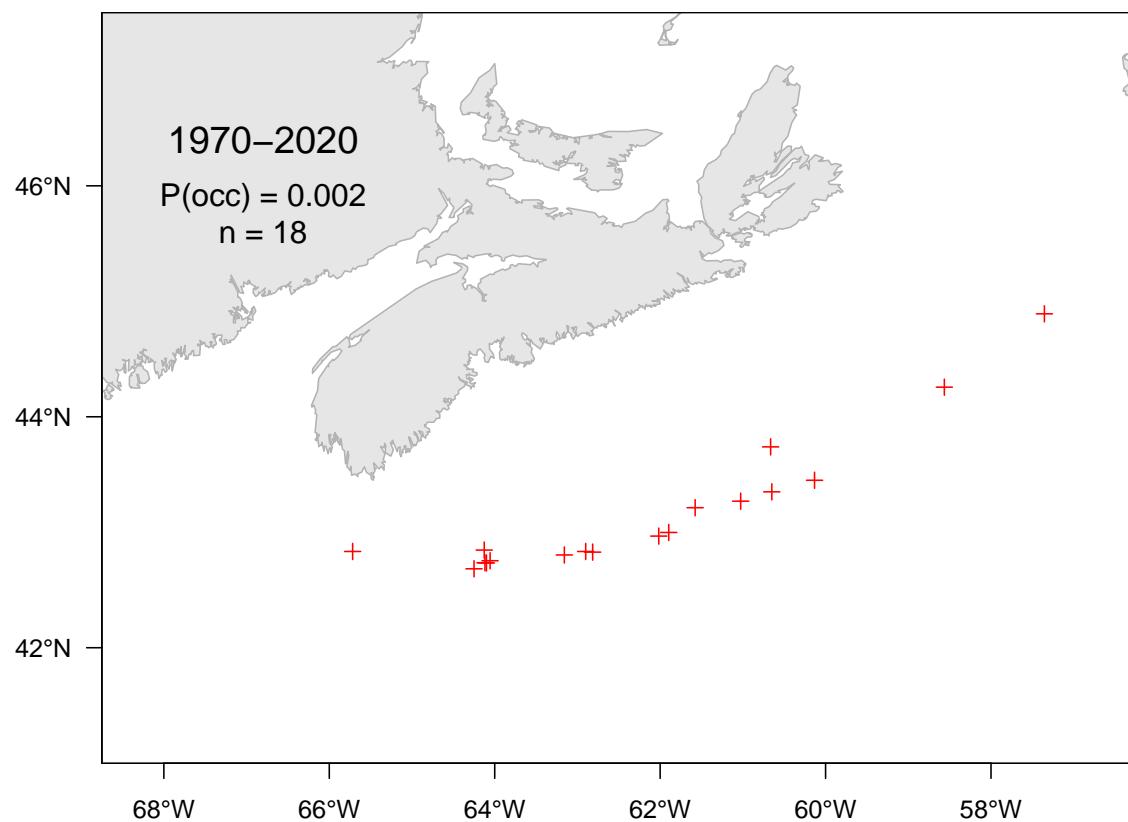


Figure 7.100A. Catch distribution for Atlantic batfish.

1167 **7.101 Spottedfin tonguefish (Langue fil noir) - species code 816 (category LR)**

1168 Scientific name: [Symphurus diomedeanus](#)

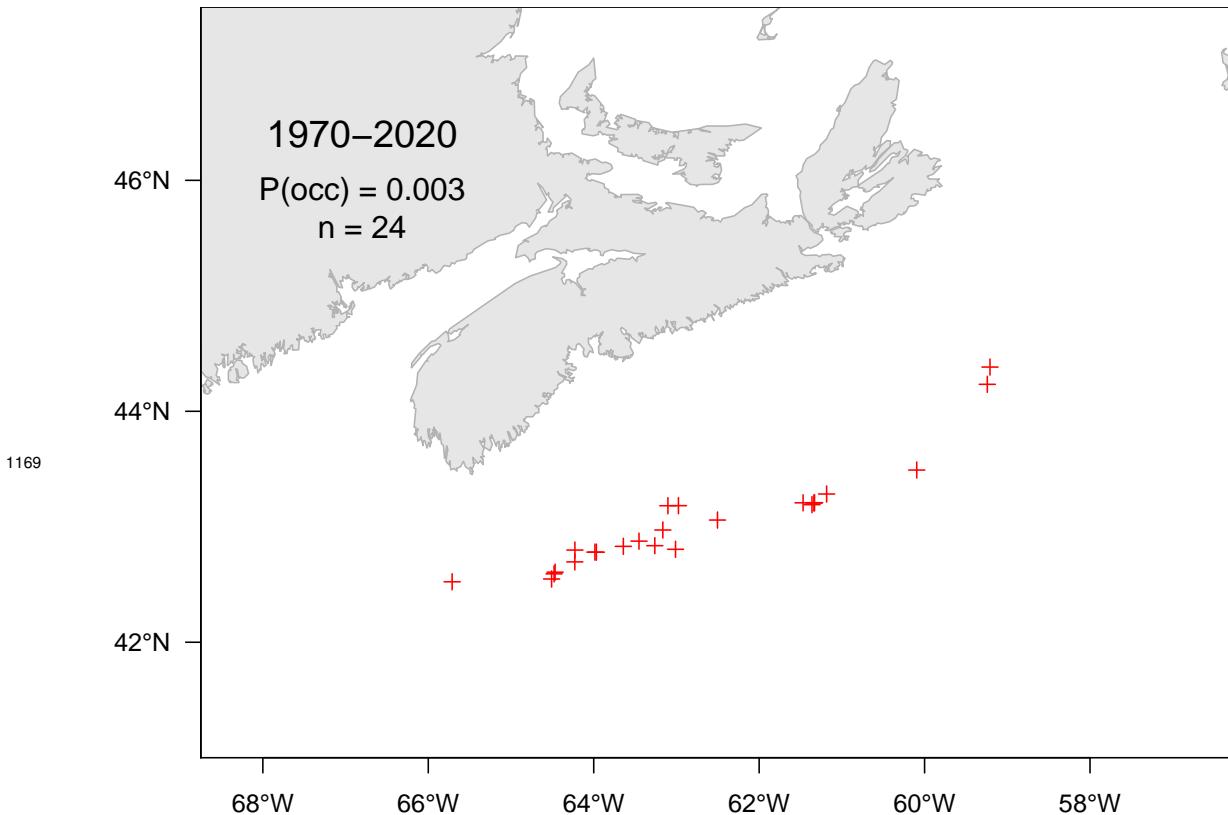


Figure 7.101A. Catch distribution for Spottedfin tonguefish.

1170

7.102 Black dogfish (Aiguillat noir) - species code 221 (category LR)

1171

Scientific name: [Centroscyllium fabricii](#)

1172

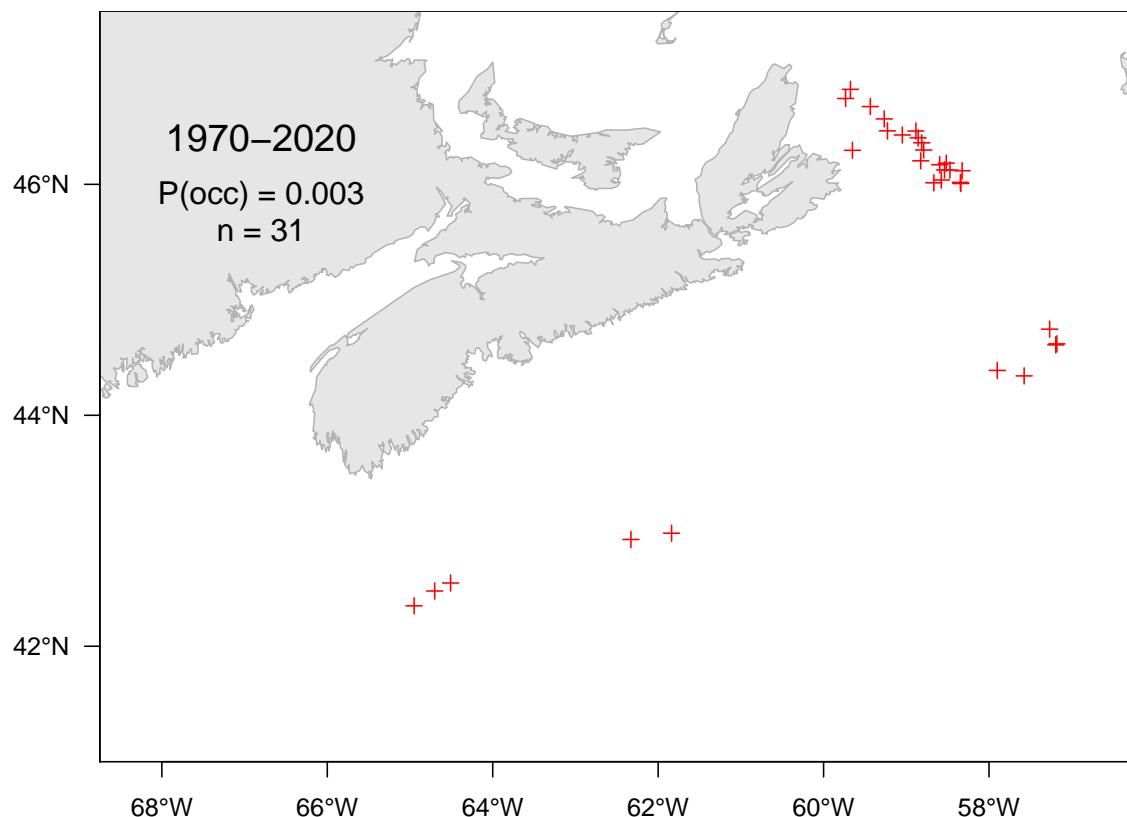


Figure 7.102A. Catch distribution for Black dogfish.

1173

7.103 Longfin inshore squid (*Calmar totam*) - species code 4512 (category LR)

1174

Scientific name: [Doryteuthis pealeii](#)

1175

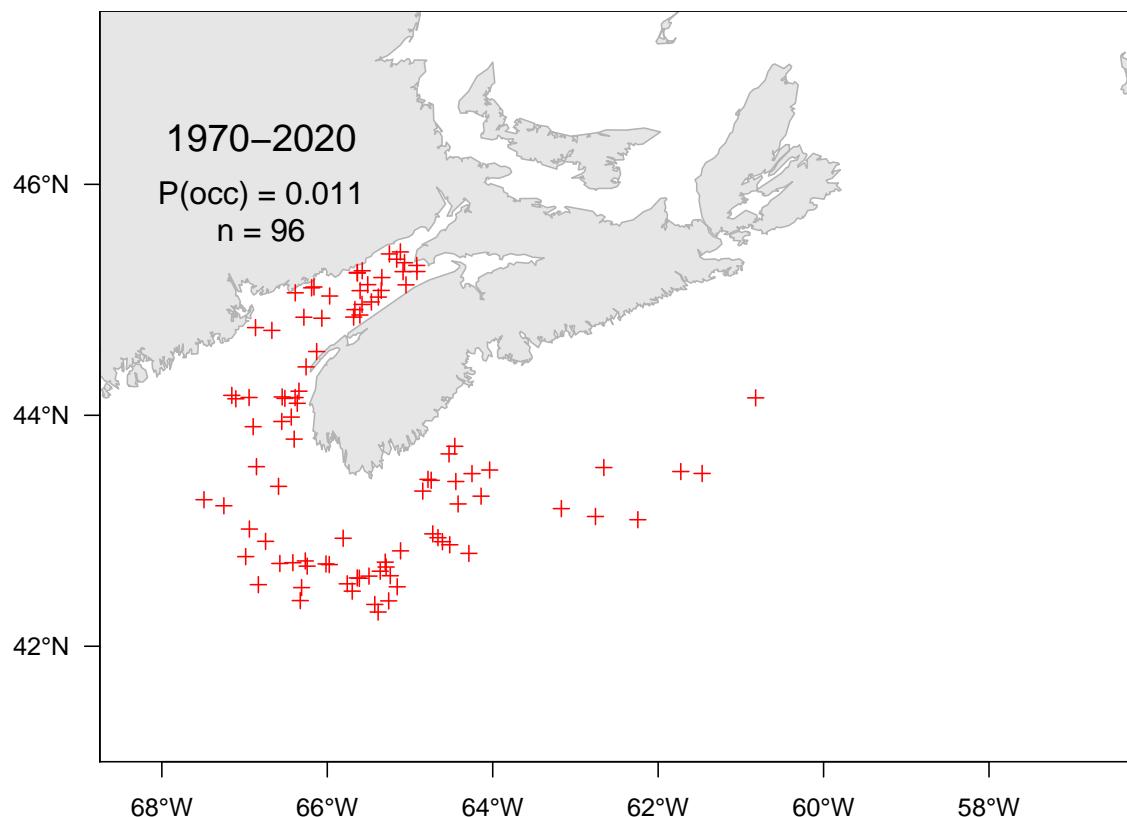


Figure 7.103A. Catch distribution for Longfin inshore squid.

1176

7.104 Red deepsea crab (Crabe rouge) - species code 2532 (category SR)

1177

Scientific name: [Chaceon quinquedens](#)

1178

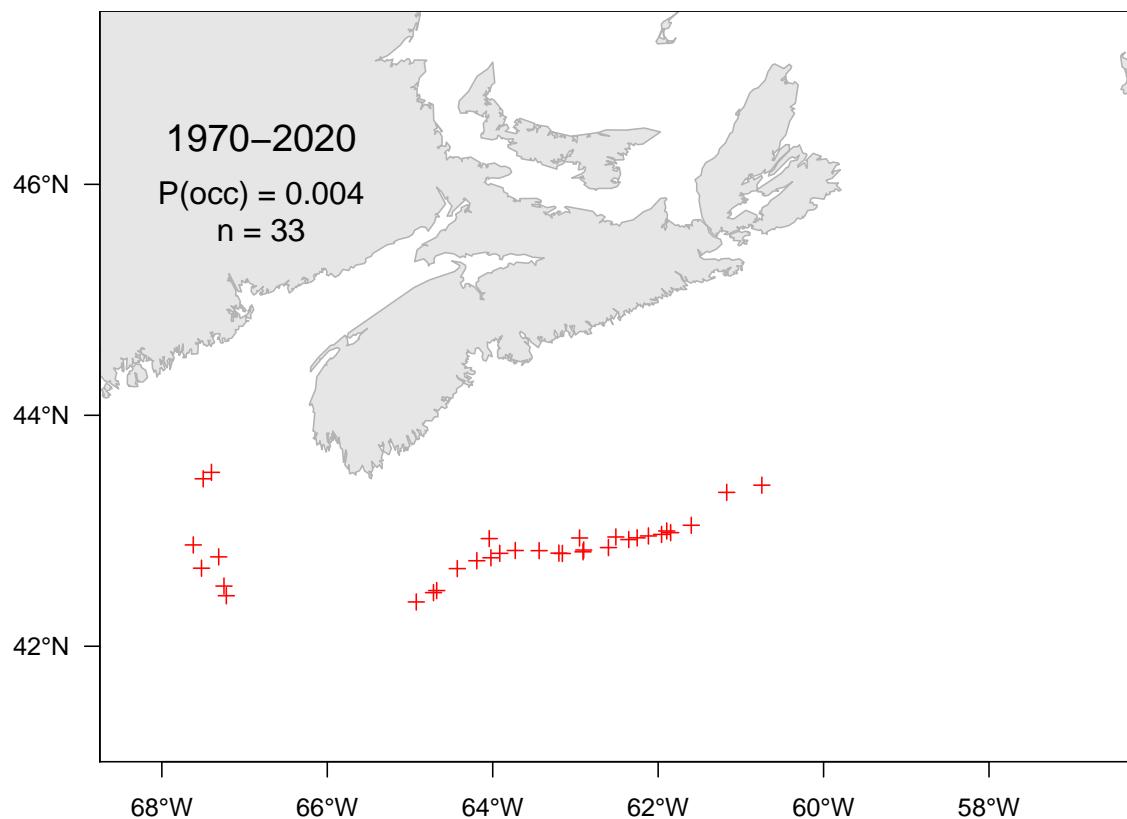


Figure 7.104A. Catch distribution for Red deepsea crab.

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